copy 3

JUN 27 1932

Volume XII June, 1932 Number 3

THE JOURNAL OF DENTAL RESEARCH

(Continuing the Journal of the Allied Dental Societies)

EDITED BY

J. L. T. APPLETON, JR. Philadelphia
ELMER S. BEST Minneapolis
BASIL G. BIBBY Rochester, N. Y.
ARTHUR D. BLACK Evanston
JAMES R. BLAYNEY Chicago
C. F. BÖDECKER New York City
R. W. BUNTING Ann Arbor
H. E. S. CHAYES New York City
FRANK COLYER London
EDGAR D. COOLIDGE Chicago
KAETHE W. DEWEY Pittsburgh
MARTIN DEWEY New York City
F. N. DOUBLEDAY London
WM. G. DOWNS, JR. Chicago, Ill.
WM. B. DUNNING New York City
GUIDO FISCHER Hamburg
HENRY W. GILLETT New York City
BERNHARD GOTTLIEB Vienna
WILLIAM K. GREGORY New York City
EDWARD H. HATTON Chicago
MILO HELLMAN New York City
THOMAS J. HILL Cleveland
PERCY R. HOWE Boston
THADDEUS P. HYATT New York City
PHILIP JAY Ann Arbor
JAN JESENSKY Prague
HENRY KLEIN Baltimore
OTTO LOOS Frankfort
E. V. MCCOLLUM Baltimore
FREDERICK S. MCKAY New York City
JOHN A. MARSHALL San Francisco
ARTHUR H. MERRITT New York City
L. M. S. MINER Boston
FREDERICK B. NOYES Chicago
BALINT ORBAN Vienna
WESTON A. PRICE Cleveland
THEODOR ROSEBURY New York City
F. E. RODRIGUEZ Camp Holabird, Md.
ISAAC SCHOUR Chicago
KURT H. THOMA Boston
M. L. WARD Ann Arbor
L. M. WAUGH New York City
B. W. WEINBERGER New York City
WM. H. WELKER Chicago

AND BY REPRESENTATIVES OF AFFILIATED SOCIETIES

First District Dental Society of the State of New York (which in 1906 established the Journal of the Allied Dental Societies, now the oldest non-commercial journal in dentistry).....JOHN OPPIE MCCALL
New York Academy of Dentistry.....MALCOLM W. CARR
American Stomatological Association:
...LEONARD... JR., New York City
American Association of Dental Editors..GRACE ROGERS SPALDING, Birmingham, Mich.
International College of Dentists:
LOUIS OTTOFY, Oakland, Cal., AND J. C. MIDDLETON SHAW, Johannesburg, S. Africa
Dental Educational Council of America.....E. FRIESELL, Pittsburgh
American College of Dentists.....ALBERT L. MIDGLEY, Providence
Robert R. Andrews Society for the Promotion of Research (Tufts)....CHARLES E. HATCH
Harriet Newell Lowell Society for Dental Research (Harvard).....HAROLD E. TINGLEY
William Jarvie Society for Dental Research (Columbia).....JOSEPH SCHROFF
International Association for Dental Research; *Sections* (Secretaries):

Ann Arbor, U. G. RICKERT
Boston, FRED R. BLUMENTHAL
Chicago, WM. G. SKILLEN
Cleveland, SAMUEL W. CHASE
Columbus, PAUL C. KITCHIN
Halifax, HUGH M. EATON
London, EVELYN SPRAWSON
Louisville, THEODORE B. BEUST
Minnesota, CARL W. WALDRON
New Haven, B. G. ANDERSON
New York, BISSELL B. PALMER
Philadelphia, THOMAS J. COOK
Pittsburgh, L. E. VAN KIRK
Prague, FRIEDRICH NEUMANN
St. Louis, C. O. SIMPSON
San Francisco, J. S. SHELL
Toronto, A. J. BROUGHTON
Vienna, EMERICH KOTANYI
Washington, G. C. PAFFENBARGER
Winnipeg, E. ROY BIER

Association (General Secretary): WILLIAM J. GIES, *Executive Officer of the Board of Editors*

PROPERTY OF
DENTAL LIBRARY
UNIVERSITY OF MICHIGAN
DO NOT LOAN OR
REMOVE

PUBLISHED BI-MONTHLY AT MT. ROYAL AND GUILFORD AVENUES, BALTIMORE, MD.
BY
THE JOURNAL OF DENTAL RESEARCH, INC.

EDITORIAL OFFICE, 632 West 168th St., New York City
Copyright, 1932, by The Journal of Dental Research, Inc.
Entered as second-class matter June 24, 1919, at the Post Office at Baltimore, Maryland, under the act of March 8, 1879

Made in United States of America

Quotations on the Status of Dentistry

The greatly improved standing of the dental profession among the professions . . . . is one of the most striking changes in public opinion that I have witnessed during my seventy years of observation of educational progress. . . . . I do not think I have seen during my seventy years of observation of the professions and the means of training them any change so great as that which has taken place in regard to the dental profession, and to the means of training dentists.—*Charles W. Eliot, President Emeritus of Harvard University,* on "The progress of dentistry and of the dental profession." *Address before the Dental School Society of the Phillips Brooks House Association, Harvard University, December 8, 1924; Harvard Dental School, 1925, pp. 14 and 19.*

The dental school is one of the most important of these agencies [for the training of a qualified body of public health servants]. . . . . Today under the leadership of the best men in the profession it has set its face resolutely toward high service and honorable standards. . . . . It must have generous financial help, such as has been accorded in the last ten years to many of our medical schools, if it is to carry out its duty to the public health service. There is today no more direct method by which the public health can be served than to enable the universities to place their dental schools in a position to give the kind of education for which the world stands in need.—*Henry S. Pritchett, Ph.D., LL.D., Sc.D., Carnegie Foundation's Bulletin on Dental Education (1926); Preface, p. xx.*

I think it unlikely that physicians, unless they have a particular interest in the border subjects between medicine and dentistry, will maintain a permanent interest in dental research. This interest may be fostered for a period of special grants, but after these grants are used up or the individual matures, he will probably revert to medicine and not be a permanent investment for dentistry. . . . . The nucleus of . . . . [the] research group [for the advancement of dentistry] in my opinion must be dentists who have had the dental training and have a permanent interest in this field, who have taken the time to get additional training in some of the preclinical sciences. This of course corresponds to the make-up of the preclinical science group in medicine today. I feel a strong conviction, therefore, that individuals who would help dentistry should first help to develop research workers with dental training and dental interest.—*G. H. Whipple, A.B., M.D., M.A., Sc.D., Dean and Professor of Pathology, School of Medicine and Dentistry, University of Rochester; New York Journal of Dentistry,* 1931, i, p. 159; April.

The stomatologist's concept of dental education and practice finds expression in the activities of a very limited group in this country who, so far as I can see, are making no headway in dissecting a part of the practice of dentistry from its whole and grafting it on medicine; nor do I believe that medicine would welcome such implantation. I have no apprehension over the stomatologist's point of view. In the four countries in Europe, Austria, Czecho-Slovakia, Belgium and Italy, where one must possess a medical degree to practise dentistry, the poorest type of technical dental service is to be found. In Switzerland, Sweden, Norway and parts of Germany, where dentistry is taught in conjunction with medical studies, yet independent of medical supervision, as we teach it in this country, the best type of service is found. Based on my own study of the problem in Europe [1926–27], I would both seek and recommend the services of dentists trained in the latter countries during the past decade and would avoid service in the former, unless I knew the dentist and his work personally.—*Guy S. Millberry, D.D.S., Dean, Dental School, Univ. of Calif.; Pacific Dental Gazette, 1931, xxxix, p. 415; June.*

Nothing is to be gained by converting a first-class dentist into a mediocre medical practitioner. . . . . I do not believe it is practical to unify the dental and medical curricula so as to provide for the same training of dentists and physicians during any considerable part of their academic careers. . . . . Dentistry is a very specialized field of medicine which has already been elevated to a standard of professional excellence entirely comparable with that of other medical specialties. *The average American dentist is at least as well qualified to render adequate service in his field of work as is the average otolaryngologist, ophthalmologist, or surgeon* [italic not in the original]. Dental education in America has been notably effective, and that is to the credit of the profession. . . . . Changes should not be made at the expense of that which has been found good through long practical experience. . . . . I am . . . . entirely unconvinced that any plan for the unification of the dental and medical curricula would result in the

(Continued on p. 3 of the cover)

INTERNATIONAL ASSOCIATION FOR DENTAL RESEARCH

Scientific Proceedings of the Tenth General Meeting[1]
Hotel Deshler-Wallick, Columbus, Ohio
March 19 and 20, 1932

Compiled by WILLIAM J. GIES, F.A.C.D., *Secretary*[2]
Columbia University, New York City

CONTENTS

I. President's address..... 412
II. Index of names of participants, and sequence numerals of corresponding abstracts..... 414
III. First session: Morning, March 19; abstracts 1–7..... 415
IV. Second session: Afternoon, March 19; abstracts 8–18..... 426
V. Third session: Evening, March 19; abstracts 19–27..... 440
VI. Fourth session: Morning, March 20; abstracts 28–36..... 452
VII. Fifth session: Afternoon, March 20; abstracts 37–48..... 458
VIII. Sixth session: Evening, March 20; abstracts 49–53..... 467
IX. Papers read by title: abstracts 54–111..... 483
A. Contributions by members of the Vienna Section: abstracts 54–73..... 483
B. Contributions by other members of the Association, and by guests, who could not be present: abstracts 74–111..... 512
X. Data of executive proceedings..... 565

---

[1] The sessions of the Research Association preceded, by agreement, those of the Ninth Annual Meeting of the American Association of Dental Schools, in the same hotel, March 21–23. The members of each body were welcome at, and participated in, the sessions of both associations. The chairmen were the President, Dr. A. E. Webster, Dental School, University of Toronto, and the Vice-president, Dr. E. H. Hatton, Dental School, Northwestern University. The annual informal dinner, served to members and guests on the evening of March 20, was attended by 114 persons. A statement of the executive proceedings, to supplement the data on p. 565 of this issue, will be published in the number for December, 1932. The president's address, and abstracts of the papers, presented at the general meeting in 1931 were published in the *Journal of Dental Research*, 1931, xi, pp. 437–540; June.

[2] Most of the abstracts have been prepared by those who presented the corresponding papers. All revisions have been verified by the authors.

I. President's Address[3]

The Value of Research in Dentistry

A. E. Webster, D.D.S., M.D., L.D.S., F.A.C.D., Faculty of Dentistry, University of Toronto, Toronto, Canada

My first duty is to thank the members for placing me at the head of the most virile organization in dentistry. It is an honour to be chosen to preside over any dental organization, but especially is it an honour and a privilege to preside over a body so modest and yet so progressive. The members are so interested in their own problems of research that they haven't time to take note of the rapid advances of the whole body, and its influence on dental education and dental practice.

Let me crave your indulgence, if I fail to give you the time-honoured president's address, which traces the progress of the Association from its inception until now. Let me, instead, discuss with you the value of research in dentistry. Few of us stop long enough from our pressing duties to take stock as to where this Association found dentistry ten years ago, and where it finds it today. Dentistry didn't know it had problems to settle, much less the organization to grapple with them. Research was acknowledged to be a good thing, but who could do it? Today there are hundreds of research workers in dentistry and allied subjects. Only a few years ago one heard the lament that research workers were born not made, but as soon as the organization and money are provided there will be no scarcity of efficient workers. Dentistry didn't know there were allied subjects, nor did the workers in allied subjects know that dentistry had problems to solve. The meetings of this organization every year have brought together research workers from every field of science (thanks to our Secretary, who knows his way about in science). Dental research workers rub shoulders with each other and learn the language of science, and thus the gospel of sound thinking is spread abroad in the land.

The greatest value in the study of science is to remove the mystery from nature, and thus bring joy to human life by the removal of its greatest enemy, *fear*. The study of science tends to clear away the

[3] Read at the dinner preceding the sixth session. See page 467.

mist and fog; it makes for clear thinking. The scientific method of approach to a subject clears away much of its difficulty. The first step is to collect the known facts; the second, to arrange and classify them; the third, with the help of imagination and reason, to weigh all the factors, draw conclusions, and discover a law. The collection of the facts is the drudgery of science; very essential but requiring a sense of discrimination only. The classification clears away the dead wood, and reduces the material to be studied. The final deductions and conclusions, which are drawn from all the data, require the greatest mental grasp, and are the real productive part of research. Many can collect facts, fewer can arrange them, and still fewer can draw correct conclusions.

The more nearly our conduct is governed by our reason the more intelligent we think we are, and yet we are compelled to admit that in most things we are governed far more by our sentiments, superstitions, and traditions than by our reason. We rarely reason concerning our politics or our religion. With all our boasted science we still sow grain and set eggs by the moon. I have known professors of higher mathematics to revert to their primitive beliefs when they went hunting or fishing, because they waited for a dry moon. The small boy cures the pain in his side by picking up a flat stone and spitting on the under side, and replacing it in the spot from which it was lifted. The primitive mind is so filled with beliefs, sentiments, superstitions and traditions that it cannot think straight on the most obvious things. As a matter of fact the wisest of the human race are not far removed from witchcraft, soothsayers and ghosts. Often one is astonished at his own friends who are otherwise sensible people, when they express the view that ghosts were to be seen in a certain house on Thursday nights at eleven o'clock, or that evil spirits are transferred from one person or animal to another by the agency of witches. One is bound to marvel at the mental processes in the mind of those who believe such things. Either their mental training has meant nothing to them, or they are mentally deranged. You say, "all bosh;" but there isn't a person in this room who hasn't some little private superstition about rain, the moon, Friday, or the number thirteen. There is always some mystery about medicines or about the people who discover them. There is a common belief that nature

produces a cure for every ill, if it could be found. People who believe in ghosts, spooks, evil spirits, and the like, have not followed the scientific method of learning, which is to collect the facts, classify, and arrange them, draw conclusions or derive general laws from them. The mind may be loaded down with facts and fail to classify them, or have them arranged; and incapable of reaching any logical conclusion based upon these facts.

The present researches in dentistry get little past the collection of data. Some may get to a classification, but few have discovered a common law. Because a law has not been discovered it does not follow the labor has been in vain. Data have been collected and classified which will be useful in the future. *But what is far more important has happened: the scientific method of approach has been developed.* Many young men and women have got an insight into methods of thinking. Research in a dental department of a university is a stimulus to the student body. The members of the faculty learn to teach with more logic and scientific order than before. The graduates who have a training where research is going on will not "fall for" the quack-medicine vendor who can cure abscesses or trench mouth by a single application of his medicine. The same scientific methods that were applied to solve dental problems will be applied to the purchase of stocks, bonds, and equipment. If research in dentistry would reach its highest place it must do more than solve the riddle of the pulpless tooth or the organic matter in enamel. It must bring to the people joys and pleasures and comforts they never had before. It must sweep away some of the miseries, misfortunes and fears, so distressing to children and the uneducated. If dental research could do nothing more than separate the unknown in the majority of dental minds, it would have justified all that has been done.

II. Index of Names of Participants, and Sequence Numerals of Corresponding Abstracts

Adams, 15; Agnew (M. C.), 24; Agnew (R. G.), 21, 24, 109; Applebaum, 74; Appleton, 18, 47, 48; Arnett, 19; Bartels, 75; Bethke, 25; Beust, 26; Bibby, 30; Bloom, 76; Boulger, 41; Boyle, 7; Bronner, 6; Bunting, 9, 22, 50; Cahn, 91; Chase, 25; Cook (F. E.), 1; Cook (T. J.), 36, 37; Cottrell, 2; Crane, 38; Cross, 77, 78; Crowley, 9; DeRényi, 17; Dewey, 13; Dienen, 99; Dixon, 28; Dobbs, 32; Downs, 79, 80; Driak, 54; Dwyer, 81; Ennis, 19; Fischer, 82; Foley, 44, 45; Gies, 53; Gordon, 75; Gottlieb, 55; Greenberg, 10; Grohs, 56;

Grossman, 46; Hagan, 14; Hanke, 83, 84; Hard, 22; Hill, 25; Hodge, 31; Hofer, 57, 58; Husband, 35; Jay, 9, 22; Kaplan, 38; Karshan, 16, 45, 85; Keilty, 23; Kellner, 59; Kick, 25; Kitchin, 1, 5; Klein, 86, 87; Knighton, 30; Kotanyi, 60; Krasnow, 88, 89, 90; Kronfeld, 42; Laidlaw, 91; Lantz, 105, 107; Leonard, 51; Lewis, 48; Lischer, 96; Logan, 43; Losch, 92; Lundquist, 11; McBeath, 93; McCollum, 86, 87; McFarland, 4; McKeown, 79; Mann, 38; Mathis, 61; Matthews, 94; Mueller, 39; Myers (R. E.), 3; Myers (V. C.), 15; Neustadt, 95; Orban, 55, 62; Orton, 96; Pichler, 63, 64; Preisecker, 65; Price, 97, 98; Proell, 99; Pulaski, 18; Rickert, 28; Rieger, 66; Rosebury, 10, 16, 44, 45; Schönbauer, 67; Schour, 100; Schram, 101, 102; Schubert, 103; Schwarz, 68; Scott, 110; Sedwick, 104; Sicher, 69; Skidmore, 20; Skillen, 11; Smith (H. V.), 106; Smith (M. C.), 105, 106, 107; Sprawson, 108; Spring, 70; Stanton, 27; Stathers, 20; Stein, 71; Tisdall, 24; Toronto Oral-Research Group, 109; Trauner, 66; Van Dyke, 100; Ward, 110; Waugh, 8; Webster, 49; Weinmann, 72; Werther, 47; Wheeler, 12; Willman, 40; Withrow, 1; Wolf, 73; Worman, 101, 102; Wright, 111; Wylie, 33; Yant, 33; Youngburg, 29; Zemsky, 34, 52; Zugsmith, 13.

III. First Session: Morning, March 19; Abstracts 1–7

1. Some Physical Properties of Certain Denture Model Materials

Paul C. Kitchin, M.S., D.D.S., Dental School, and Frank E. Cook, M.S., and James R. Withrow, Ph.D., Engineering Experiment Station, Ohio State University, Columbus, Ohio

There appear to be no available data to help dental workers to select suitable denture model materials for the production of the most accurately fitting dentures. In this preliminary endeavor to obtain such data, twelve commercial materials were subjected to "expansion-on-setting" tests. One of the twelve was then tested for fineness, initial and final sets, and compressive strength after a 1-hour set and a 24-hour set. A summary of the results follows:

(1) The "expansion-on-setting" of these materials varied from 0.23 percent expansion to 0.20 percent contraction, a spread of 0.43 percent. (2) The greater the water content of the mix, the less the "expansion-on-setting." (3) Sample 7 was selected for the remaining tests because it was one of the newer, "white," quick-setting, hydrated-gypsum products showing a not-excessive "expansion-on-setting," service tests indicating great strength, and no disintegration in the vulcanizer. It was so fine that 90 percent passed through a 200-mesh screen. (4) In Sample 7, the initial set varied from 8 to 10 minutes, and the final set from 12 to 14 minutes, depending upon the water content of the original mix. (5) The compressive strength of Sample 7

varied from 2000 lbs. per sq. in. to 3000, depending upon the water content of the original mix. (a) There was no difference between the compressive strengths after a 1-hour set and after a 24-hour set. (b) The greater the original water content, the lower the compressive strength.

In the "expansion-on-setting," the greater the water content, the less the expansion. Another factor, which evidently affected this expansion, was the setting-time of the material itself. This is illustrated by the fact that all the quick-setting materials exhibited some expansion, whereas the slow-setting ones showed considerable contraction at the start of the set. Later this was followed by an expansion. The net result of this contraction and expansion, at times, was almost zero. It seems that the initial contractions were due to loss of water by evaporation, since they were accompanied by no detectable physical change. In Sample 7, a stiff putty-like mix gave an initial set of 8 minutes and a final set of 12; a mix of creamy consistency gave an initial set of 10, and a final set of 14. The initial set may be taken as a fairly good indication of the maximum time that may be allowed for the mixing and pouring, and the final set as the maximum time that may elapse before the trimming of the mold must be completed. There was apparently no relationship between the final set as determined and the expansion-on-setting. The compressive strength for Sample 7 showed that there was very little difference in the strength of the cylinder after a 1-hour set and after a 24-hour set, both being approximately 3000 lbs. per sq. in. for the putty mix. Here again water played an important part. An increase of 7 parts per 100 by weight of water (the difference between the putty mix and the creamy consistency) caused a drop of 1000 lbs. per sq. in. in the strength of the cylinders. The factor that decreases expansion also appears to decrease compressive strength. It is probable that this loss is immaterial, in view of the actual degree of strength possessed by the sample. Since only one sample was used in the latter determinations, no comparisons between the materials can be drawn at this time.

Many more important tests could and should be made on these materials, among them (a) the effect, on expansion, of heating and cooling; (b) compressive strength after vulcanization; (c) effect of time, and manner of mixing, on the expansion and strength of the

materials. (d) Volume changes on setting, and on heating and cooling, should be tabulated against the volume changes of vulcanized rubber on cooling, for the purpose of formulating combinations that would result in dentures having the least net deviation from the original tissue structure.

2. THE DEVELOPMENT OF A DENTURE WITH CONSIDERATION OF THE TISSUE UPON WHICH IT RESTS

H. V. Cottrell, D.D.S., College of Dentistry, Ohio State University, Columbus, Ohio

A full-denture base should extend as far as the tissues that are movable by muscular contraction permit. The closer the apposition of the denture to the mucosa, the stronger the adhesion. Other things being equal, the greater the area, the stronger the adhesion. But the "other things" are never equal. Hence each case is an individual one; and we are always much concerned with the character of the tissue underlying a denture base. Palpation shows the submucosa is variable in thickness, thus accounting for the noticeable differences in firmness. Sections of the palate, suggested by Dr. Pendleton and prepared by Dr. Kronfeld, show beautifully the structure, including numerous mucous glands and fat depositions. An impression of such tissues should be taken with a plastic that records a true negative with the minimum pressure, so that the physiological function of the tissues will not be disturbed.

Any denture, when in function, compresses the underlying tissues, especially where the submucous tissues are thin. But they are not uniformly thin; so the denture rests finally upon the portions of the stressbearing area that are hardest. This fact limits the amount of pressure a denture in function may exert. A patient stops application of pressure when discomfort arises. Desire on the part of the dentist to eliminate such discomfort accounts for many attempts to provide a cushion for dentures. Dr. Hugh D. Morgan placed himself in this group a few years ago when he presented his problem to a rubber chemist, Otto Lang, who developed a material that met Dr. Morgan's needs. The principal ingredients are balata and latex. The material

is cemented to the denture. Dr. Morgan endeavored to effect an efficient union, but did not standardize the process. At first an effort was made to apply the material in thin sheet-form to the denture. It is now applied in sheets 3 mm. thick, and in a plastic state, in the operation known as "rebasing." If we have been of any assistance to Dr. Morgan, it has been in the development of the current technic, as follows:

A vulcanite denture is prepared for a rebase impression by cutting out all undercuts from the denture, together with any further cutting which may be considered necessary for a scientific impression of the vault, and an accurate border contact of the denture to the reflections. Such impressions should be obtained by the patient closing into centric relation under sufficient pressure to distribute the impression material into the desired form. The cast should be made with a material that tests sufficient resistance to compression to preserve accuracy, and whose volume change during setting is the least possible. The denture with cast is then flasked. After separation of the flask, and thorough cleansing of the mold, the denture should be further cut to provide at least 0.75 mm. room for the insertion of the rebase material. The latter preparation is accomplished by using a wheel bur whose blades are 0.75 mm. in length. The use of such a bur, to cut parallel grooves across the denture base about 2 mm. apart, provides an easy finish of the grinding process by using a larger vulcanite bur to cut off the elevations between the grooves. Both parts of the flask are then placed in a heating unit of 160° F. for at least fifteen minutes; a longer time is not harmful. This process drives off a large water content from the investment material. The denture is then flushed with low-test gasoline, which is a solvent of the cement and therefore facilitates rather than antagonizes the penetration of the vulcanite by the cement. After drying out slightly, the denture is painted with thin cement. When the cement has reached at least the "tacky" stage in the process of drying, a second coat is applied so that every part of the surface of the vulcanite will certainly have been covered with cement. Meanwhile, a sheet of the material has been sand-papered on one side to remove the glaze, and then subjected to sufficient heat to render it very pliable but not sticky; the cast has also been painted with a good model-dressing. The plastic material is next applied approximately and quickly to the cast with the sanded side up. When the cement has

reached the "tacky" stage, the flask is started in the closing process. The time consumed, from the first application of cement to this stage, is about five minutes. The temperature of the cast will have been lowered about 10°F., whereupon (150°F.) the flask is subjected to the press for gradual closure to within 0.5 mm. of complete closure. After allowing the case to cool for 30–40 minutes, sufficient pressure should be applied to drive the material, by means of the cast, firmly against the denture, but without any slipping of the material, which in other words, must be too cool to slip. The case is thus held under molecular strain, and with firm pressure against the denture, for a minimum period of eight hours, or until the cement has set. The flask should then be subjected to 160° F. for 15 minutes and then completely closed. This suggested temperature releases the molecular strain on the material and thus eliminates its tendency to loosen, especially from a concave surface. The case may now be cooled as quickly as desired. When released from the investment, the excess may be easily torn loose and a sharp knife employed to further trim the excess smoothly. Fine sandpaper may then be used to finish the edge. The material cannot be polished. The velvety surface which sandpaper leaves will not, however, irritate the mucosa. At this stage, the denture fits better than a vulcanized case because of the elimination of the element of shrinkage through which the vulcanite has passed.

It was stated above that a denture under masticatory stress rests on the thinnest sub-mucous areas. These areas of support may be very much increased by immersing the denture in hot water (160° F.) and carrying to the mouth, followed by the patient bringing the teeth together with masticatory stress. There will be a consequent slight drifting of some of the material from the hardest spots to the more compressible areas near by. One may now observe that the adhesion is stronger as a result of a more nearly uniform bearing of the denture on the mucosa. Patients observe they can bite harder with more comfort than at any time before, for the same reason plus the cushion that the material provides. The original impression having been procured with the tissues under minimum pressure, as indicated above, the conditions enable the tissues to tolerate this distribution of pressure without interference with their physiological function.

3. VARIABLE PRESSURE REGULATED TO PREVENT REBOUND OF MOLTEN METAL DURING CASTING[4]

Raymond E. Myers, D.D.S., School of Dentistry, University of Louisville, Louisville, Ky.

Molders have long found difficulty in successfully producing castings of areas relatively extended in proportion to thickness. In ordinary dental work, failures are probably due to the congealing of the metal before it penetrates to the farthest recesses of the mold cavity. For some types, thin plates, discs, and other designs of extensive area and of thin section, the use of only one sprue is not successful, the molten metal when subjected to pressure in the usual way failing to spread throughout the mold cavity even when considerable pressure is applied. This phenomenon can nearly always be observed in the casting of a 28-gauge full upper-denture base-plate with one sprue-former of average size attached in a perpendicular direction to the center of the vault. While it is difficult to ascertain the exact conditions prevailing during a casting operation, my theory is that the advancing portion of the molten metal "rebounds" on reaching the end of the sprue, if the air pressure has been applied suddenly or in excessive amount. Experiments performed to determine whether the failure of the molten metal to spread after reaching the end of the sprue was due to "rebound," indicated that the manner in which the molten metal entered the mold was a factor contributing to the success of the casting process, and suggested the desirability of a method to prevent this difficulty. The solution of the problem depends upon effective means for the advancement of the molten metal to the end of the sprue without "rebound," and subsequent application of sufficient pressure to complete the casting. The author's design of such a precision mechanism which, in the greater number of cases, automatically produces substantially perfect castings, includes regulation of the following factors: specific, relatively-low pressure; definite time-interval between the application of low pressure and the beginning of the gradual increase in pressure; rapidity with which gradual increase in pressure is effected; and maximum degree of gradual increase in pressure.

[4] Published in the *Journal of Dental Research*: 1932, xii, p. 327.

4. METHOD TO SECURE UNIFORM THICKNESS IN SECTIONS GROUND ON THE BLACK TYPE OF APPARATUS

R. D. McFarland, D.D.S., Dental School, Ohio State University, Columbus, Ohio

Accurate parallel alignment of the disc and grinding wheel of a Black grinding-lathe is essential to the production of a ground section of uniform thickness. Since the disc has a revolving motion when mounted on the lathe, its periphery will be nearest the grinding wheel if its surface is not parallel to the stone. Where one section is mounted on the disc, the ends of the section will be thin and the center thick. Where two sections are mounted on the disc on either side of its diameter, the sides of the sections nearest the periphery of the disc will be thinnest and the sides nearest the center will be thickest. Heretofore the dressing of the grinding wheel, in an attempt to insure its being parallel to the disc, has been accomplished by the use, on the lathe bed, of a special attachment carrying a vise, into which was placed the handle of the diamond dressing-pencil. The vise was placed on the top of several movable platforms one sliding upon another. The base of this special attachment for dressing the grinding wheel was fastened to the lathe bed by means of a bolt and thumb-nut. Mounted upon this base was a platform allowing for movement of the dressing tool across the grinding wheel. On this platform was another that revolved on an axis allowing it to be set at zero degrees, or theoretically at right angles to the grinding-wheel shaft. On this platform was another that allowed for movement of the dressing tool toward and away from the grinding wheel. The vise to hold the diamond dressing-tool was placed on top of the apparatus. The correct adjustment of the above apparatus, with its several movable parts, was supposed to allow one to dress the grinding wheel at right angles to the lathe-bed upon which the attachment holding the disc to be dressed was placed. This apparatus, having given poor results in our work, has been replaced by the following simple yet accurate device for dressing our grinding wheels (*fig. 1*):

As a dressing tool we use a diamond mounted in a grinding disc, with the diamond projecting slightly from the disc surface and as close as possible to the periphery of the disc. As this disc-held

diamond revolves, the part of the surface of the grinding stone later used on the specimen is dressed in a plane at right angles to the revolving shaft holding the disc in place. New discs may now be surfaced and made parallel to the previously prepared grinding wheel with an assurance of accuracy, for in terms of geometry two planes parallel to the same plane are parallel to each other. Material to be sectioned is then ground and polished so as to have a plane surface before being mounted on the grinding disc. This material is then mounted flat on the disc and placed on the grinding machine for

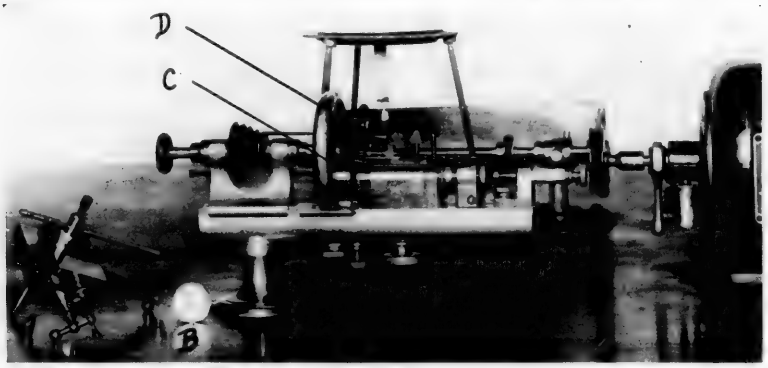


FIG. 1. PHOTOGRAPH OF GRINDING APPARATUS AS SET UP READY FOR USE
A—Apparatus for dressing grinding-wheels. *B*—Diamond mounted in grinding disk. *C*—Grinding disk in place on lathe. *D*—Grinding wheel.

finishing to the desired thickness. After grinding out many sections on this apparatus, and checking them by measurement for even thickness, we have found it very satisfactory, accurate, and dependable.

5. SOME OBSERVATIONS ON ENAMEL DEVELOPMENT AS SHOWN IN THE MANDIBULAR INCISOR OF THE WHITE RAT

Paul C. Kitchin, M.S., D.D.S., Research Laboratory, Dental School, Ohio State University, Columbus, Ohio

Polarized light was used in a study of ground sections showing enamel conditions throughout the length of the mandibular incisor of the white rat. By this means it was possible to determine the various phases in the process of crystallization of the tissue. The

following conclusions seem warranted: (1) The theory of the production of the finished calcified enamel-rod by the individual ameloblast was not supported. Instead there is first fabricated a complete organic matrix devoid of all crystal forms. This matrix is composed of septated tubes held together by thin intercellular substance and containing globular forms, one to each segment of a tube. Crystallization starts in the peripheral walls of these tubes, probably in the intercellular substance as well, and advances toward the center, the tube being crystallized first and the globules last. (2) The first crystal-forms observed are believed to be optically positive in sign with a negative sign of elongation. This statement is made with reservations, because the small amount of the crystal form makes it very difficult to determine the crystal sign. The initial crystal form changes to an isotropic condition, and finally to crystals with an optically negative sign with a positive sign of elongation. This transition occurs in that area of the incisor enamel lying approximately below the first molar. Possibly it is visible evidence of a predominantly phosphate condition changing into a predominantly carbonate condition.

The individual crystal form is hexagonal, with its unique axis at right angles to the long axis of the enamel rod. A study of decalcified sections, cut to show the length of the incisor, revealed that all enamel tissue disappeared from the material at a point coinciding with the transition and the beginning of the final crystal phase described above. It is believed that studies concerned with variation in calcification may benefit by the use of this method of attack. (To be published in the *Journal of Dental Research.*)

6. SOME STUDIES IN DENTIN AND PULP REACTIONS

Finn J. Bronner, T.L., D.D.S., College of Dentistry, New York University, New York City

Experiments were undertaken to ascertain how and to what extent dentin and pulp respond to various stimuli. As "stimulated" dentin does not exhibit the usual quick recovery demonstrable in nerve-muscle preparations after the summation effect is manifest, the presence of an accumulated X-factor must be inferred. Although nerves have

not been satisfactorily demonstrated, tests made with hypertonic saline solutions, sucrose, and glucose suggested osmosis through some membrane permeable to salt but not to sugar. In such event, pain would seem to be a result of either increased pressure or drying, depending upon which side of the membrane (Tomes' fibril?) the nerves are located. This modus operandi obviously presupposes the presence of fluid. An analysis of fresh dentin in impacted teeth, prepared under Ringer solution immediately upon their removal, showed that dentin contains approximately 12 percent by weight of colloidal liquid. The specific weight of dentin was estimated to be about three times that of this *fluid* (lymph *without* corpuscles). Consequently, this dentinal fluid occupies three times the volume of the dentin—at least 36 percent. If Römer's count of the tubuli per sq. mm. is correct, the fluid would occupy about 50 percent of the dentin by volume. Inasmuch as pain is also caused by mechanical pressure upon the dentin, the author has formulated a theory suggesting that the above mentioned X-factor is lymph accumulation, which explains at least part of the mechanism involved in the various noci sensations. Lymph being incompressible, but the dentin being very elastic, any pressure on the dentin is transmitted through these fluid columns *directly* to the pulp capillaries. As capillaries in general dilate on the application of pressure, heat, histidine, etc., a vicious cycle was shown to lead to increasing lymph exudation.

By means of thermocouples connected with a sensitive galvanometer the heat registered in the pulp chamber, by grinding and drilling at moderate speed and pressure, was shown to be high enough to jeopardize cell life (10°C. rise by 45-second grinding on the enamel). Experiments have included sensitization through the dentin of guinea pigs, diagnostic methods by heat, lymph-coagulation tests, diffusion of low surface-tension agents, acid-phosphate effect on the lymph, and permeability and insulating property of cavity linings. Facts concerning sclerosis of the tubuli, and formation of secondary dentin, were analyzed and correlated into an apparently plausible explanation of many physiological and pathological aspects of dentin and pulp reactions.

7. THE HISTOPATHOLOGY OF THE HUMAN TOOTH-GERM IN CONGENITAL SYPHILIS

Paul E. Boyle, D.M.D., Department of Pathology, Harvard Medical School; Department of Operative Dentistry, Harvard Dental School, and Pathological Laboratory of the Children's Hospital, Boston, Mass.

A report was given of the histopathological findings in the molar tooth-germs of six congenital syphilitic infants. In each case the clinical diagnosis was confirmed by the post-mortem findings. Inflammatory lesions occurring about the small blood vessels associated with the tooth-germ were described. There was an endarteritis and a perivascular inflammatory-cell infiltration associated with the blood vessels in the loose connective-tissue about the tooth-germ, in the capillary net-work in the region of the outer enamel-epithelium, about the blood vessels that penetrated the stellate reticulum of the enamel organ, and about those in the dental papilla. In places the enamel-forming cells were disrupted by an inflammatory-cell exudate, which was found on the surface of the enamel. In the three cases in which the inflammatory lesions were most marked, the temporary second-molar was involved to a much greater degree than the permanent first-molar. In one case the occurrence of globules within the ameloblasts and on the surface of the enamel was described. These globules stained similarly to the first-formed enamel matrix. Much globular, irregularly formed, enamel was also found deposited on the surface of the previously formed, regularly arranged, enamel, in the same case. In all the teeth, there was evidence of defective calcification of the dentin. Interglobular spaces were numerous; in some instances the globules of calcium salts were small and granular in appearance. The predentin extended for a distance of from two to three times its normal width. Pycnotic cells were frequently found in this structure. The dental pulp showed an inflammatory-cell infiltration, which was usually less marked than that occurring in the enamel organ of the same tooth-germ. The odontoblasts varied from well arranged, nearly normal cells to dwarfed, poorly arranged, pycnotic cells that could hardly be distinguished from the cells of the rest of the dental papilla. In places the odontoblasts were separated by an intercellular accumulation of fluid.

Three of the six cases were hospitalized, and received vigorous antisyphilitic treatment for periods of varying length before death. In each case there was evidence of improvement in the calcification of the dentin corresponding to the period of treatment; in one, of the resumption of enamel formation; in the other two, of a new formation of stellate reticulum in the enamel organ. It is believed that the latter phenomenon has not been previously described. Several cases showed atrophy of the enamel-forming cells, particularly over the tips of the cusp; in one, a permanent first-molar of a three-month old child showed a small dentin cusp with beginning enamel formation at its apex. The ameloblasts were so atrophied they were hardly recognizable, and the stellate reticulum had disappeared except for a very small area between the cusps. The enamel organ was represented by a stratified squamous epithelium backing the degenerating ameloblasts. The dentin was very poorly calcified, and the predentin was the widest of any in this series. In several places, small capillary loops were included in the predentin. Because of the similarity of these findings to those described by Wolbach and Howe,[5] in the teeth of vitamin-A deficient rats, other tissues were studied and, on the basis of a metaplasia of the epithelium of the trachea and the pelvis of the kidney, a diagnosis of keratomalacia was made by Dr. Wolbach. It is believed that this is the first recorded case of the substitution of stratified squamous epithelium for the normal enamel-organ in the human.

IV. Second Session: Afternoon, March 19; Abstracts 8–18

8. A study of the influences of diet and of racial admixture on the development of the jaws and face of the American Eskimo

Leuman M. Waugh, D.D.S., F.A.C.D., Dental Surgeon Reserve, United States Public Health Service; Department of Orthodontia, School of Dental and Oral Surgery, Columbia University, New York City

In the three reports previously made before the Association the problem of dental caries was discussed. (Waugh: *Journal of Dental*

[5] Wolbach and Howe: *Journal of Experimental Medicine*, 1925, xlii, p. 753.

Research, 1928, viii, p. 428; 1930, x, p. 387; 1931, xi, p. 453.) This report deals with the growth and development of the jaws and face. (Forty-five illustrations were used in the presentation.) Mummery, about 1887, in reporting studies of the teeth of various races, stated that the Eskimo, a people of small stature, had the largest jaws and best teeth of any known race. This statement was found to be true of the Eskimo in Labrador, as well as in Arctic Alaska, so long as he lived the primitive nomadic life of his ancestors. However, when he adopts white man's diet and mode of living, there is marked deterioration both in size and strength of the jaws, and in regularity of the teeth. This occurs in startling degree even in one generation. *The change in food is the determining factor.* When subsisting as did his ancestors, his food consisted of proteins and fats almost exclusively—the former to the extent of 65 percent in some settlements. These embraced the red meats of seal, walrus, sea lion, whale, balooga, caribou, reindeer, bear, trapped animals, birds, and fish of various kinds. They were hung in the sun to "cure;" and, because of the purity of the air and the prevailing low temperatures in the summer—average for June, July, and August about 40°F.—they became dry and hard, and required much rugged chewing when eaten. In the winter, they were frozen solid; and, because a seal-oil "lamp" was the only means of providing heat for cooking, which was slow and inadequate, this frozen food was eaten without preparation beyond putting it in the igloo for a short time to thaw. Fish and meat were generally dipped into the oil of the seal as it was eaten. Fats formed the remainder of the diet—sometimes as much as 65 percent. This rugged chewing of food is beyond question the great factor in jaw development, as the children have little other food after weaning. Newly erupted teeth have cusps, grooves, and fossae, as deep and well formed as those of white children; but, because of the heavy mastication, the occlusal surfaces soon become so much worn that, by 12 to 14 years of age, they are quite noticeably flattened. This is probably due in part to grit picked up when the fresh meat and fish are thrown on the rocks prior to "curing." As the occlusal surfaces become abraded, still greater muscular effort is necessary for mastication. All this undoubtedly stimulates growth of the jaws and size of the face. Not only do the dental arches assume a larger regular outline, with a

strong tendency to assume the inverted letter-U form, but the body of the jaws and the alveolar process are very thick and strong. The degree to which this occurs should be of special interest to the orthodontist in his effort to stimulate bone growth without appliances on the sound physiologic principle that "the use of an organ determines its strength," that "function begets structure," and that bone is under the dominance of actuating muscles. Exercises properly selected and persistently performed by the patient must be helpful in the stimulation of jaw development. The Eskimo also use their teeth in softening the raw, dry hides from which they make their muk-luks—native boots—clothing, harness, etc., etc. It is the rule that at 16 years or over, the teeth are much worn, often to half the length of the crowns; at 25 to 35 they are worn almost to the gum. This is more noticeable in women, who "make" the equipment.

In natives aged 24 to 40, a prominent bulging-ridge is frequently noticeable on the labial and buccal surfaces of the alveolar process over the *cervical* half of the root, and a more prominent one, about one-fourth inch wide, on the lingual side of the lowers along the *apical* half of the roots. This the author regards as adventitious alveolar process, due to excessive and persistent chewing. This full, almost bulging, alveolar process is suggestive of that seen in such lower animals as the ape. In marked contrast to the foregoing is the lack of this thick, strong, development in the jaws of natives who get so-called "white man's food" from prospectors, miners, traders, and stores. The Eskimo, especially the young, prefer sweet, soft food that requires little chewing; and, when thus fed, the children of rugged-jawed parents have very noticeably smaller and less strongly formed jaws. Under these conditions, which are unnatural for them, irregularity of the teeth becomes as extreme as in American children, and occurs in from one to two generations.

Racial admixture among the Eskimo almost invariably results in notably smaller jaws, with a strong tendency to narrow, crowded, dental arches. The typical Eskimo-arch is replaced by one of *oval* tendency, with markedly less prominence of the upper cuspids. This seems to hold true equally for admixtures with Indians, Chinese, or whites. The teeth of the half-breed are also much more susceptible to decay. The third molars of the Eskimo are frequently small and

rudimentary; often one or more are congenitally absent. Radiograms of eleven such cases failed to disclose one case of impaction. A radiographic study was made of fourteen mouths in which the teeth had been worn practically to the gums. The pulp chambers appeared to be filled with secondary dentin, and the canals appeared as fine lines, with the half toward the crown almost obliterated, but in no case was there evidence of pathology about the root end. The foregoing gives further support to the author's earlier conclusion that "the American Eskimo is veritably paying for his civilization with his teeth." (To be published by the United States Public Health Service.)

9. THE RELATIONSHIP OF THE OCCURRENCE OF BACILLUS ACIDOPHILUS IN HUMANS TO SKIN SENSITIVITY AND SPECIFIC AGGLUTININS IN BLOOD SERUM

Philip Jay, M.S., D.D.S., Mary Crowley, M.S., and R. W. Bunting, D.D.S., D.D.Sc., F.A.C.D., Research Laboratories, Children's Fund of Michigan, School of Dentistry, University of Michigan, Ann Arbor, Mich.

In a previous publication we suggested a possible relationship between skin sensitivity to B. acidophilus filtrates and the presence of B. acidophilus in the mouth as well as the occurrence of dental caries. This was based on the observation that caries-susceptible individuals, in a large majority of cases, responded locally to intradermal injection of filtrate. Caries-free individuals, on the other hand, yielded negative or doubtful skin-tests. It was also found that purified filtrate was less specific in this relationship than unpurified filtrate. It was further reported that two patients had been successfully desensitized after repeated inoculations of a polyvalent B. acidophilus vaccine. The resulting negative skin-reaction was accompanied in both cases by the appearance of B. acidophilus agglutinins in the blood serum. The present report deals with a comparative study of caries-free and caries-susceptible children, with special reference to skin sensitivity to the purified B. acidophilus filtrate and the occurrence of B. acidophilus agglutinins in the blood. Both feces and saliva were cultured for B. acidophilus. Actual counts were made of the organisms in saliva.

In this study, the relationship between positive skin-tests and the presence of dental caries was not quite so impressive. Only 68 percent of the susceptibles gave positive skin-tests, whereas almost 30 percent of the caries-free children were also positive. Although purified filtrate was not as specific as unpurified filtrate, there was still a tendency for the positive reactions to occur in the susceptible group. B. acidophilus agglutinins were demonstrated in the blood sera of caries-free individuals in much higher dilutions than in sera of susceptibles. The highest titre in the caries-free group of 23 cases was 1–640; they usually ran as high as 1–320. The highest titre of 25 susceptible cases was 1–80 (in one case), the majority being negative. Feces cultures of all susceptibles were positive for B. acidophilus. The only negative feces-cultures were obtained in the caries-free group. B. acidophilus counts in saliva were very high in the susceptibles; the caries-free counts were negative or extremely low.

10. ACID PRODUCTION AND RESISTANCE OF LACTOBACILLI IN RELATION TO DENTAL CARIES[6]

Theodor Rosebury, D.D.S., and Samuel Greenberg, D.D.S., Department of Bacteriology, College of Physicians and Surgeons, Columbia University, New York City

These experiments aimed to determine the limits of acid production and the relative resistance to acidity of lactobacilli; and, on the basis of these properties, to compare lactobacilli from mouths with and without dental caries. Acid-production limits were evaluated in the following manner. Titration of media and all pH determinations were made on a glass electrode, employing a vacuum-tube potentiometer. A 2-percent-glucose, dilute (1:6) veal-broth was titrated to a series of pH levels between 2.8 and 6.6. Each series was inoculated under oil with the strain to be tested, using a uniform inoculum of saline suspension (30–35 million organisms), incubated 7 days at 37°C., and the pH determined. The final pH of the cultures was lowest in the tubes of lowest initial pH. No growth, as determined by pH change, occurred at pH 2.8. By plotting the pH change at each

[6] Conducted with the aid of a grant from the Commonwealth Fund for research in dental caries.

level for each strain against the initial pH of each level, a linear graph was obtained for the more active strains, which, extrapolated to zero pH change, was taken to represent the pH limit attainable by that strain, and the level below which no growth occurs. This limit was found to lie above pH 3.0 for the most active strains, including the majority of human dental and intestinal strains, and above pH 4.0 for the least active strains, including mainly rat strains, which were similar in this respect to B. coli and Staph. aureus. The average, for a given strain, of the final pH values in the tubes of a series in which growth occurred, was called the "mean significant pH" of the strain. This is a closely reproducible value for stable strains, and is, in general, inversely related to the characteristic growth-strength of the strain.

Preliminary tests suggested that the degree of acid resistance of lactobacilli varies, theoretically without limit, with variation in the number of organisms inoculated, and the length of time they are exposed to the acid medium. The following method, however, yielded interesting results. Mouths, classified after careful examination as "carious" and "caries-free" were cultured in a routine manner into sterile Locke solution, and equal volumes of this seeded into 2-percent-glucose (stock) veal-broth tubes at pH 3.6, 4.1, and 4.6. These were incubated anerobically for 48 hours at 37°C. and streaked on 1 percent glucose-agar. A group of rats on normal and caries-producing diets were also cultured in the same manner. While growth was obtained from most of the human "caries" and rat mouths, from the pH 4.6 medium, and from about 40 percent of the human "caries-free" mouths, the 3.6 medium yielded growth only in the human "caries" cases. This suggests a difference in acid-resisting properties between lactobacilli from mouths with caries and without caries. Yet, when strains thus isolated were later seeded in equal numbers (30–35 million organisms) into similar acid media, incubated 18 hours aerobically at 37°C., and streaked on 1 percent glucose agar, all strains tested, including members from the three sources, grew out from all pH levels. Additional acid-production tests on these same strains, however, continued to show characteristic strain differences, yet failed to distinguish between "caries" and "caries-free" strains as a whole; both groups were predominantly "strong," while rat strains, whether from caries or normal mouths, were predominantly "weak."

It appears unlikely, therefore, that acid production or acid resistance of the resident lactobacilli is a factor of difference between mouths with and without dental caries. The possibility that the difference obtained in the initial acid cultures was due to a disparity in numbers of organisms in the mouths, rather than in kind, is being tested further.

Strains from rat mouths, whether with caries or without, have thus far been consistently weaker acid-producers than those obtained from human mouths. This is correlated with a parallel difference in growth strength. Whether this is a stable group-characteristic, or the reflection of a difference in natural environment, is not yet clear. Except for the difference found in acid resistance on initial culture, which disappeared when the conditions of the test were altered, the strains of lactobacilli from mouths with caries and without appear to be alike, in both human beings and rats, in what may be termed their potential caries-producing power; although the strains from rats differ as a group in being weaker in this respect than the forms from human mouths. Further studies, aimed particularly to explain the initial difference in acid resistance, are under way. (The first part of this work will be published in the *Journal of Bacteriology*.)

11. FINDINGS IN A PRELIMINARY EXPERIMENT ON PULPECTOMY IN TEETH OF DOGS

William G. Skillen, D.D.S., and G. R. Lundquist, D.D.S., Department of Histology, Northwestern University Dental School, Chicago, Ill.

In a study of the reactions of the apical structures, the results indicated below were obtained in eight animals (52 teeth) in experiments ranging in duration from twelve hours to five weeks. For the removal of variable amounts of pulp, we used the broach or cautery, the latter being more satisfactory for the purpose. Strict asepsis was sought; no medication was employed; some root-canals were left unfilled; all teeth were securely sealed. Regardless of every care, infection occurred in a number of instances and was noticeable as early as twelve hours after pulpectomy. Where it did not occur, the periapical inflammatory reaction was relatively mild—a little hemorrhage and a few scattered leucocytes being observable at twelve hours, with the same light leucocytic infiltration persisting to the end of the five-week period.

The relation to the problem at hand of the slight resorptive reaction noticeable at all periods in the bone, in uninfected cases, is questionable. Such a process is not unusual under ordinary conditions. The pulp-stump, and tissue occupying the many very numerous apical ramifications, underwent a progressive degeneration after twelve hours. The size of the pulp-stump, and the injury it received, seemed to have some bearing on the degree of degeneration at any particular time. In no instance, except in infected cases, did all the ramifications in any tooth show the same degree of degeneration. With necrosis in apical ramifications, there appeared to be corresponding degeneration of cement corpuscles in neighboring lacunae. After two weeks, degeneration of cement corpuscles occurred over wider areas of the innermost layers of the cementum. This may or may not be related to death of the pulp. In the acute inflammatory cases, the cementum bounded by destroyed periapical tissue was entirely necrotic by the fifth week. Initial necrosis under similar conditions was noticeable at two weeks. In some of the latter cases, reparative bone-change was noticeable. But this was probably a response to the mechanical needs of the situation rather than to any change in adjacent tissues.

12. EVIDENCES OF A COMPENSATING CURVE IN THE INDIVIDUAL UNITS OF THE HUMAN DENTAL ARCH

Russell C. Wheeler, D.D.S., Washington University, St. Louis, Mo.

Much has been written, on occlusion, about relative positions of the teeth—types of faces and skulls, relative measurements of skulls according to landmarks—but very little about the design of the various units, namely, the teeth. These, most directly concerned in the ideal occlusion, are designed and well on their way to complete form before final development of the investing tissues; or, for that matter, long before the face and head of the individual are fully formed. In working out tooth arrangement for a patient, the teeth should be classified as to *size* and *shape*. It is entirely possible that the *type* of tooth, if we could classify it, would be a valuable aid in diagnosis. Classification could be done scientifically—fitting the individual's measurements with his requirements, both as to type and size of tooth-form, and relative size of arch, including a definite occlusal-curve depending upon these measurements.

A study of photographs of individuals, extracted teeth, or good casts shows that much of the plan of occlusion exists in the teeth themselves. It has been stated that, in normal development, the position and angle of the teeth in the jaws are brought about mainly by function—gradual settling to place depending upon form and function. When development is normal the teeth come into their respective positions at the proper time; and the occlusal curve, with its dimension, is produced according to the form of the teeth originally established. The teeth are not arbitrarily placed to make this design. This is shown by the proper variation in angle of the individual teeth. Of course, if something interferes with development of the jaws and proper eruption of the teeth, the efficiency is lost and the occlusion is not in harmony with the tooth forms.

Heretofore we have thought of the teeth as being so placed as to accommodate themselves to the direct forces of mastication only, which would mean that they are so formed that the occlusal surfaces are at right angles to the long axis. This would also presuppose the necessity for variation in these axes to accommodate themselves to a Curve of Spee. Instead, the anterior teeth viewed from mesial or distal, and the posteriors viewed from buccal or lingual, are all curved. A line drawn through an individual member of the arch describes an arc that is parallel generally to those passing through the opposing members in the upper or lower arch, whichever it may be. The axes of these circles are on a line parallel approximately to the occlusal surface of the lower first-molar. The second molars describe a smaller circle; the third molars, one with the same radius, or more often a smaller radius. The axes of these imaginary arcs are on a line with the occlusal surface of the second molar. If the teeth were not curved in this manner, and there were no compensating occlusal curve, the forces of mastication in centric would tend to cause them to drift. Photographs, actual size, show without question the compensating curve reflected in each individual tooth. An effort was made to level the occlusal and incisal surfaces, thus standardizing the position in order to show the difference in angulation of the occlusal surface in relation to the long axis of each tooth.

Conclusion. More thought should be given to the anatomy of the individual teeth in restoration, especially in bite-opening cases and

other work where engineering plays a part. In orthodontia, also, there has been a tendency to overlook the design of the individual members of the arch. Since the teeth themselves are designed before growth of the jaws is complete, or function has time to act, they should be observed more closely, and the form and size used as controls, and as references in diagnosis and treatment, with due regard also for the proper position of the roots. This is as important as the occlusal line, from two viewpoints: efficiency in function, and stabilization of the completed arches.

13. EXPERIMENTAL INVESTIGATIONS OF THE TISSUE REACTIONS IN IMPLANTATION OF ARTIFICIAL TEETH AND OTHER FOREIGN BODIES

Kaethe W. Dewey, M.D., Department of Clinical Pathology, and Robert Zugsmith, D.D.S., Department of Physiology, Dental School, University of Pittsburgh, Pittsburgh, Pa.

Observation of apparently very satisfactory clinical results in implantation of artificial teeth, and of appliances for the support of prosthesis, as practised by Brill in Berlin, led the authors, in animal experimentation, to ascertain how far the histological findings corroborate the clinical appearances. Four incisors were extracted from the upper jaws of dogs, and four artificial roots (polished gold, and silver, and glazed and unglazed porcelain) placed into the sockets, and held there by a bridge anchored by post inlays to the two outer of the six incisor teeth. Provisions were made to eliminate all mechanical stress on such roots. In another set, artificial roots with crowns were so implanted as to subject them to normal as well as over-occlusion. In this way we are endeavoring to learn the mode, rate, and degree of epitheliation of the walls of the sockets, and the behavior of the alveolar bone and the periosteum, in the presence of foreign bodies composed of different materials with rough and smooth surfaces and subjected to the action of various external and internal forces. In a test with an artificial canal prepared by drilling a hole through the maxillary bone from the labial to the palatal side, into which a silver rod was inserted, it was found that in nine days a layer of squamous epithelium developed along the wall of the artificial canal—in some parts, twice the thickness of the adjacent normal surface-epithelium.

The work is in progress. The rôle played by bacteria in implantation of foreign bodies will be included.

14. TWO CASES OF NOMA: ONE FATAL, THE OTHER RECOVERING

C. W. Hagan, D.D.S., Department of Children's Dentistry, School of Dentistry, University of Pittsburgh, Pittsburgh, Pa.

Case A. A white male child, 2½ years old, was admitted to the Children's Hospital of Pittsburgh with the following symptoms: swelling of the cheek; loose grayish exudate in the mouth on the left side of the upper jaw; very foul breath; marked enlargement of the submaxillary and cervical lymph glands; temperature, 104°F. The blood picture indicated lymphogenous leukemia; mouth smears showed Vincent's spirillum and fusiform bacillus. In spite of treatment these conditions became progressively worse, and the patient expired on the fifteenth day after admission.

Case B. A white male child, 4½ years old, upon admission to the Children's Hospital showed a grayish exudate on the buccal mucous-membrane; pharynx reddened, but without a membrane. Under medication this condition cleared up and the child was discharged at the end of seventeen days. Twelve days later he was readmitted, with an extensive, gangrenous, stomatitis and dermatitis involving the mouth, tongue, lips, and anterior half of the neck as far as the clavicle. Under treatment the gangrenous area finally healed by cicatrization, causing great deformity of the mouth and neck and stricture of the esophagus. (To be published in the *Journal of the American Dental Association.*)

15. AMYLOLYTIC ACTIVITY OF SALIVA

Victor C. Myers, Ph.D., D.Sc., and W. Lloyd Adams, M.A., Department of Biochemistry, Schools of Medicine and Dentistry, Western Reserve University, Cleveland, Ohio

In a correlated study of amylolytic activity, and chloride and phosphate contents, of saliva in 26 medical and dental students, the amylolytic activity was determined by the method of Myers and Dellenbaugh (*Proceedings of the Society for Experimental Biology and Medicine*, 1918–19, xvi, p. 18). This "amylolytic index" gives a true measure of amylolytic power, which, although fairly constant in a

given individual, varies with different individuals. It was thought that the electrolyte content of the saliva (chiefly sodium chloride) might be an important factor in explaining the variation, especially since many workers have shown that sodium chloride is an activator of amylase. The method entails a 1:100 dilution of the saliva with distilled H_2O. To show the augmenting action of NaCl, a similar determination was made with 0.3 percent NaCl as the diluent. With H_2O as a diluent the index varied from 25 to 48; with the NaCl diluent, it varied from 41 to 60. By arranging the data for 21 subjects that were free from colds, on the basis of the increased activity brought about by the NaCl diluent, a corresponding difference in the salt concentration of the saliva was disclosed. By averaging the findings for the 4 subjects at the top of the list, and for the 4 at the bottom, we found that for the 4 at the top—who showed an average increase in the index of 19 (a rise from 31 to 50) when 0.3 percent NaCl was used as the diluent—the NaCl content of the saliva averaged 65 mg. per 100 cc.; and the total P, 14 mg. But for the 4 individuals at the bottom, showing an average increase in the index of 7 (a rise from 45 to 52), the NaCl content of the saliva averaged 116 mg. per 100 cc.; and the total P, 20 mg. These findings suggest that the chloride content of saliva, and to a less extent the phosphate content, have important influences upon the amylolytic index of a given individual. Each of the 4 subjects in the top group had good teeth and gums, one of them having perfect teeth; whereas 2 of the 3 subjects classified by the student health-service as having poor teeth and gums were at the bottom of the list. This matter is now being investigated further.

The amylolytic indices of five subjects who contracted severe colds during the period of the study were invariably low, 18–24, when the colds were most severe. In these cases the salt content of the saliva did not appear to influence the amylolytic index.

16. CORRELATION OF CHEMICAL AND PATHOLOGICAL CHANGES IN TEETH OF RATS ON RACHITIC AND NON-RACHITIC DIETS[7]

Maxwell Karshan, M.A., Ph.D., and Theodor Rosebury, D.D.S., Department of Biological Chemistry, College of Physicians and

[7] Part of this work was conducted with the aid of a grant from the Chemical Foundation for research in biochemistry.

Surgeons, Columbia University, and the Laboratory of Seaside Hospital, Staten Island, New York

It had previously been shown[8] that a severe rachitic diet, high in Ca and low in P, produced no significant changes in the ash, Ca and P of the incisor teeth of rats; although there were large reductions in these constituents in the tibias. When the Ca:P ratio of the diet was reversed, however, to make it low in Ca and high in P, there ensued a reduction of the ash, Ca and P in the incisors as well as in the tibias. When both Ca and P were low, the changes were similar to those on the low-Ca, high-P diet. The reductions of ash, Ca and P in the incisors were approximately 10 percent from normal. When cod-liver oil was added to the low-Ca, high-P, and to the low-Ca, low-P diets, the ash, Ca, and P rose to normal levels. The present study involves the histological changes in the incisors and molars of these animals, particularly with reference to a comparison of the chemical evidence with the histological findings relating to degree of calcification. The sections of incisors were made of extracted teeth, and all material was decalcified before sectioning, so that no information about enamel was available. In general the dentinoid of the incisors of rats on the high-Ca, low-P diet was within normal-breadth limits, in agreement with the chemical findings. The molars were somewhat affected, the dentinoid of the roots being irregularly broad, and the alveolar bone showing extensive osteoid formation. The incisors of the rats on the low-Ca, high-P diet, and the low-Ca, low-P diet, on the other hand, presented marked dentinoid formation, indicative of reduced mineral content, again in agreement with the chemical findings. The molars, on these low-Ca diets, showed the dentinoid uniformly broadened throughout the teeth, and the alveolar bone again markedly altered. The addition of cod-liver oil to the low-Ca diets, after a period of feeding sufficiently long to produce marked dentinoid formation, restored the dentin to normal.

It thus appears that a high-Ca, low-P diet, although very deleterious to bone, does not appreciably affect calcification of the rat incisor as determined by both chemical and histological analysis. The same diet affects the molars to a less extent than low-Ca diets, which, whether

[8] Karshan: *Journal of Dental Research*, 1930, x, p. 64; 1931, xi, p. 267.

high or low in P, produce marked changes in incisors and molars, as well as in bone. The changes observed histologically in the incisors of rats on the low-Ca diets were more marked than the chemical findings seemed to indicate: a reduction of 10 percent in ash, Ca, and P being correlated with dentin that appeared to be about 40 percent dentinoid. The absence of enamel in the histological analysis might, of course, account for this discrepancy.

17. CENTROSOMES IN THE CELLS OF THE INTERNAL ENAMEL EPITHELIUM

Geo. S. de Rényi, M.D., Anatomical Laboratory, School of Medicine, University of Pennsylvania, Philadelphia, Pa.

Based on the grade of their structural and functional differentiation, the cells of the internal enamel epithelium were divided into four regions. In the first, the cells are polygonal in shape and not organized into a distinct layer of epithelium. The cells of the second region, termed pre-ameloblasts, are well organized, but do not exhibit functional activity. In the third region, the cells reach their final structural differentiation and are ready to execute their ultimate functional activities. The cells of this group were termed young ameloblasts. The fourth region is composed of true ameloblasts. During development, the cells of the internal epithelium pass through the stages mentioned above. In this process, the direction of their activity is reversed. This is synchronous with the dislocation of the centrosomes. The diplosomes are always located between the nucleus and the active surface. The location of the centrosome is an accurate indicator of the grade of functional differentiation of the cells of the inner enamel epithelium.

18. REACTIONS TO INTRACUTANEOUS INJECTION OF TUBERCLE BACILLI AND STREPTOCOCCI, TOGETHER AND SEPARATELY

J. L. T. Appleton, Jr., B.S., D.D.S., and E. J. Pulaski, School of Dentistry, University of Pennsylvania, Philadelphia, Pa.

Into each rabbit four intracutaneous injections on the ventral surface were made of (*a*) tubercle bacilli (50,000); (*b*) tubercle bacilli (25,000) and *alpha* streptococci from periapical infection $\left(\frac{x}{2}\right)$; (*c*)

same streptococcal strain (x); and (*d*) sterile "hormone broth," the vehicle for the bacterial suspensions. Both human and bovine strains of tubercle bacilli were used. The volume injected at each site was uniformly 0.1 cc. Records of areas of reaction were made with a pantograph. No reaction occurred where the "hormone broth" alone was injected. Within 24 hours, a diffuse area of redness appeared at the site where the streptococci alone were injected. The reaction here progressed rapidly, sometimes going on to abscess-formation or to ulceration. Eventually, healing was completed within a month. Where the tubercle bacilli and streptococci were injected together, the reaction progressed much more slowly than where the streptococci alone were injected. An abscess and ulceration slowly developed and the lesion constantly progressed. It usually required 8 to 14 days before any reaction was observable at the site where tubercle bacilli alone were injected. This lesion remained smaller than the one that occurred where both organisms were injected together. The reaction resulting from the injection of 50,000 tubercle bacilli alone was less than that from the injection of 25,000 tubercle bacilli plus streptococci. Where human tubercle bacilli were given, progress of the lesion was arrested early and healing eventually resulted. Regardless of the strain of tubercle bacilli employed, the results have been constant in that the greatest reaction over the longest period occurred where tubercle bacilli and streptococci were injected together.

V. Third Session: Evening, March 19; Abstracts 19–27

19. Association of periapical infections with extra-oral affections

L. M. Ennis, D.D.S., and John H. Arnett, M.D., School of Dentistry, University of Pennsylvania, Philadelphia, Pa.

In a routine physical (general and dental) examination of students at Drexel Institute, Philadelphia, the data given in *tables 1* and *2* were collected. The age-range was that for the first year in college. There was no significant difference, between the groups "with granulomata" and "without granulomata," as to rheumatism, chorea, "heart trouble," underweight, or albuminuria.

TABLE 1

Incidence of various conditions in students with and without dental granulomata

	WITH GRANULOMATA		WITHOUT GRANULOMATA	
	Number	Percent	Number	Percent
Students	175	100	708	100
Rheumatism, chorea, and heart trouble	5	2.9	21	3.0
Underweight (10 lbs. or more)	44	25.1	153	21.6
Albuminuria	12	6.9	27	3.8

TABLE 2

Incidence of electrocardiographic changes in 160 students with and without dental granulomata

	WITH GRANULOMATA		WITHOUT GRANULOMATA	
	Number	Percent	Number	Percent
Women electrocardiographed	27	100	133	100
Normal tracings	23	85.2	109	82.0
Tracings showing some departure from "normal"	4	14.8	24	18.0

20. ASYMMETRICAL DENTAL STIGMATA IN CONGENITAL SYPHILIS

F. R. Stathers, D.D.S., and R. M. Skidmore, D.D.S., School of Dentistry, University of Pennsylvania, Philadelphia, Pa.

The study is based on 105 cases of congenital syphilis from the Wills Eye Hospital, Philadelphia. The ages ranged from 4 to 40 years. All showed interstitial keratitis. There were 4 cases of deafness, and 16 (15+ percent) showed unmistakable Hutchinsonian teeth. The differentiation from the dental stigmata of nutritional (rickets) or exanthematous origin may be made with confidence when the observer has had enough experience. In 7 of the 16 cases the Hutchinsonian dental stigmata were asymmetrical. This is contrary to current general opinion. The patients and models clearly show that there were cases of Hutchinsonian incisors without affected molars; mulberry molars without affected first and second incisors; one affected incisor without the stigma appearing in the corresponding incisor. Two points of interest stand out: The full Hutchinson triad in congenital syphilitics is rare. (2) The relative frequency of asymmetric distributions of the dental stigmata calls into serious question some of the theories on the etiology of these stigmata.

21. MICROSCOPIC STUDIES OF PARADENTAL TISSUES

R. Gordon Agnew, B.A., D.D.S., F.I.C.D., Schools of Dentistry, University of Vienna, Vienna, Austria, and University of Toronto, Toronto, Canada

Calcifications in the pulp, under the terminology of denticles or pulpstones, etc., have long been described and various classifications have been made. Relationship between certain of these types and epithelial cells, presumably from the original sheath of Hertwig, has been suggested. Likewise, calcifications in the periodontal membrane are almost constantly observed, and the general term "cementicle" has been loosely applied to them. Some cementicles are believed to arise from nuclei consisting of degenerating or necrotic connective-tissue elements, or of thrombi, etc. Other so-called cementicles are believed to originate from epithelial cells in the periodontal membrane, again considered in most cases as vestigial remnants of the sheath of Hertwig. Around these calcified masses larger or smaller masses of cementum may be built up, so that free, adherent or interstitial cementicles have been described. Again, sundry calcifications are frequently encountered in the gingival tissues. In some of these, the tissues involved are seen to be of epithelial nature; in others, of connective-tissue type. The rôle of the epithelial cell in cementicle formation has been the subject of considerable controversy.

Studies of serial sections of a large mass of human material in Toronto and in Vienna have brought to light an unusual type of calcification in the paradental tissues. Lesions have been found in the periodontal membrane, the gingival tissue, the marrow spaces of the alveolar bone and supporting bone, and in intimate relation with the bone trabeculae themselves. A typical lesion in the soft tissues presents the picture of a mass of apparently degenerating tissue surrounded by a peripheral zone of a hyaline appearance. In many instances the structure of the incorporated cells has become obliterated through the development of a presumably calcic mass surrounded by the said peripheral zone. (Since these sections had been decalcified, it is necessary of course to assume the calcic nature of these deposits from the staining reactions.) A later stage of this process appears to be reached when the entire mass assumes the character of an inert

calcic formation. In one specimen these structures are very abundant in a periodontal membrane grossly widened by erosion of the alveolar wall, and also by slight erosion of the cementum of the tooth (an upper right first-molar). Localized overgrowth of the cementum of the root has brought about the incorporation of a few of these exceedingly numerous structures. Of particular interest histologically are areas, showing bodies such as have been described above, which are seemingly incorporated in the bone trabeculae of the alveolar process and of the supporting bone. Some of the structures are deeply imbedded; others are superficially attached. Some still retain the hyaline peripheral zone; others do not. Another specimen shows similar bone involvements, and also abundant areas of epithelial cells, many of which have obviously undergone marked proliferation. In some of these proliferated zones definite histologic evidence is given of the process of calcification.

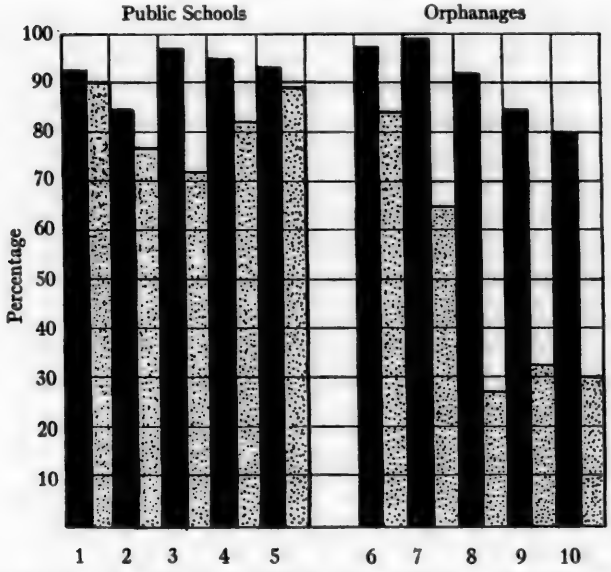
Consideration of the histological evidence suggests the following hypothesis regarding the explanation of the phenomena observed: There occurs a proliferation of the epithelial-cell nests, sometimes in the membrane about a root; sometimes in an area formerly occupied by a tooth root, the tooth having been removed by extraction, drifting, or eruption, from its original site. Subsequently these clumps of epithelium have degenerated and calcified. During this subsequent process, or following it, there has been an attempt on the part of the bone to incorporate these structures in a manner analogous to that in which the cementum frequently seeks to incorporate calcified structures in the periodontal membrane. In the process of such incorporation various histological pictures are seen, and finally there is an attempt on the part of the bone to remove these bodies entirely by replacement ossification. While this unusual calcification process occurred to an extensive degree in the cases presented, isolated zones have been observed in a number of instances. The age factor does not appear to have a direct bearing on the occurrence of this process. In view of the phenomena described, and the unsatisfactory nomenclature relative to calcifications in the paradental tissues, it is suggested that this terminology be revised; that the term "cementicle" be deleted on account of its restricted scope; and that new nomenclature based on a correlation of structure and function be developed.

22. OBSERVATIONS IN THE EXAMINATION OF THE MOUTHS OF 1192 CHILDREN IN PUBLIC SCHOOLS AND INSTITUTIONS

R. W. Bunting, D.D.S., D.D.Sc., F.A.C.D., Philip Jay, M.S., D.D.S., and Dorothy G. Hard, D.D.S., Research Laboratories of the Children's Fund of Michigan, School of Dentistry, University of Michigan, Ann Arbor, Mich.

In comprehensive surveys of the mouths of children, very interesting observations concerning the rate of caries activity during childhood, and the relative degrees of caries frequency on certain surfaces of teeth, have been noted. The examinations were made in five public schools and five orphanages in which 1192 children were observed over a period of one year. The data are an index of the degree of caries activity among American children between 5 and 15, and serve as a standard to which experiments in the control of dental caries may be compared. The data for the three orphanages in which the diet was adequate are quite different from those for the two other similar institutions in which the diet was not as favorable, and also different from those for the public school children.

In these examinations, made by four dentists having considerable experience in such work, every cavity or filling that could be discovered with the aid of a large mouth mirror and a very fine explorer was carefully recorded. Each case was examined by one operator and the record checked by another member of the group. The data represent two examinations of these 1192 children made one year apart by the same group of individuals under exactly similar conditions. No x-ray examinations were made. It must be granted that despite the extreme care taken in these surveys, errors have occurred, but the large number of children examined and the uniformity of the methods employed insure a general reliability. We estimated (*a*) the percent who at the first examination showed dental caries, the remainder being apparently free from it; (*b*) the percent who after one year showed some evidence of new cavities or extension of old carious processes; and (c) the number of cavities or extensions of old cavities per child during the year. The data, shown graphically in *fig. 2*, are given in *table 3*, where it will be noted that in the *public schools* from 85 to 97 percent of the children had dental caries previous to the first examination. It was impossible to estimate the number of cavities per child because,



Black columns = percentage of children having dental caries, first examination. *Mottled columns* = percentage of children having new or extended caries in one year. *Institutions:* 1—Donovan. 2—Angell. 3—St. Thomas. 4—Jones. 5—Grosse Isle. 6—G. P. O. 7—P. O. H. 8—Lapeer. 9—Coldwater. 10—Maumee. (See page 472).

FIG. 2. DATA RELATING TO DENTAL CARIES IN CHILDREN IN PUBLIC SCHOOLS AND ORPHANAGES

TABLE 3

Data on caries in 1192 children in public schools and orphanages

INSTITUTIONS	CHILDREN	(a) INITIAL CARIES	(b) CARIES IN ONE YEAR	(c) NEW CAVITIES OR EXTENSIONS PER CHILD DURING THE YEAR
	no.	*percent*	*percent*	*no.*
Public schools:				
Donovan	49	92	90	4.1
Angell	124	85	77	3.5
St. Thomas	161	97	72	3.5
Jones	84	95	82	3.0
Grosse Isle	169	93	89	3.2
Orphanages:				
G. P. O.	74	97	84	4.2
P. O. H.	55	99	65	2.2
Lapeer	100	92	27	2.7
Coldwater	220	85	32	1.9
Maumee	156	80	30	1.7

after the loss of the deciduous teeth, the extent to which they had been carious could not be ascertained. During the year of observation caries was active in the mouths of a large majority, ranging from 72 to 90 percent. Among these, the number of cavities and extensions averaged from 3 to 4.1 per child. In the *orphanages* the data were somewhat different. At the first examination 80 to 99 percent were carious. One year later, in one institution (G.P.O.), 84 percent had new caries (4.2 cavities per child). In another similar institution, in which the initial caries had been higher, only 65 percent showed new caries (only 2.2 cavities or extensions per child). The children at Lapeer and Maumee were carried for one year on a fairly adequate diet. In these two institutions, 80 to 92 percent were carious at the

TABLE 4

Data showing relative frequency of caries on tooth surfaces

AGES	DECIDUOUS TEETH			PERMANENT TEETH		
	No.	Occl.	Approx.	Occl.	Approx.	Buc.-ling.
5–8	351	751	1315	456	17	118
9–12	609	539	1273	1691	354	337
13–15	201	23	21	993	312	174
16–20	31	....	....	190	59	27
Total.....	1192	1313	2609	3330	742	656

first examination; after a year only 27 to 30 percent had new caries (1.7 to 2.7 new cavities and extensions per child). In another institution (Coldwater), in which the diet was quite adequate, 85 percent at the first examination had caries, but after a year only 32 percent had active caries (1.9 per child).

The relative frequency of caries on the tooth surfaces was estimated for four age-groups as shown in *table 4*. It is obvious that the figures for deciduous teeth are incomplete because many were absent at the time of examination, and their carious history was unknown. Inasmuch as no bite-wing films were taken, undoubtedly many approximal cavities in the permanent teeth were not discernible by exploration. However, the figures very clearly indicate that in the deciduous teeth approximal cavities are much more frequent than occlusal, whereas in the permanent teeth occlusal cavities are more than twice as

frequent as those on all other surfaces. These data accord with the findings published by Hyatt.

In the course of our many surveys of the dental conditions of large groups of children, we have been impressed by the importance of three general local factors in the determination of dental caries; namely, structure of the tooth, virulence of the attacking force, and

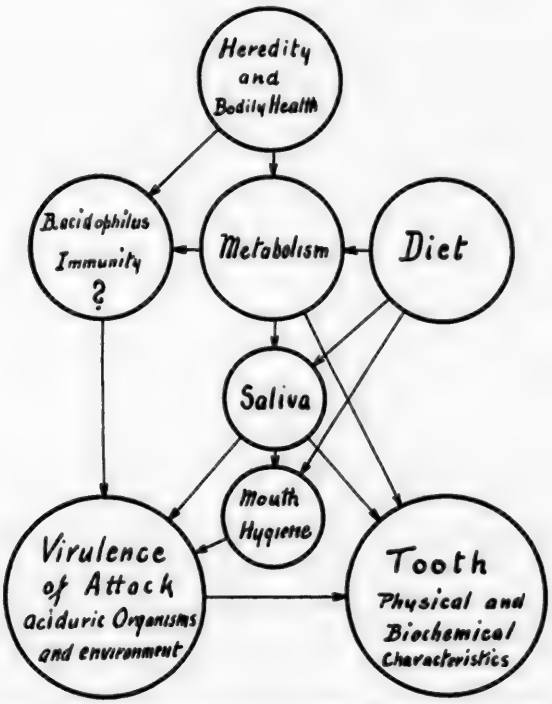


FIG. 3. GRAPH SHOWING COMPLEX RELATIONSHIP DEPICTING PRESENT VIEW OF MICHIGAN GROUP ON CAUSATIVE FACTORS IN DENTAL CARIES

mouth hygiene. It has seemed that the occurrence of dental caries and the degree of its activity are directly determined by a balance of these three forces. Teeth, through their physical and biochemical characteristics, appear to offer variable degrees of resistance against the activity of caries. The virulence of the attack seems to depend upon hygiene, and the presence of aciduric bacteria under conditions

in which the acids they produce may affect the teeth. The factor of hygiene ranged all the way from mouths teeming with bacteria and containing many open cavities to those in which the teeth were fully repaired and scrupulously clean. The interactions of these three factors were the observed outstanding characteristics in the process. They are definitely related to, and determined by, underlying bodily conditions such as heredity, general health, diet, metabolism, and, possibly, immunologic reactions. The diet may affect the hygiene of the mouth and the activity of the aciduric bacteria, directly through the character of the retained food materials, or indirectly through metabolism and alterations in the salivary secretions. Metabolism may also influence the physical and biochemical characteristics of the tooth through alteration of either the salivary secretion or the blood stream. These complex relationships are represented in *fig. 3*, which depicts the present views of the Michigan group as to the causative factors in dental caries.

23. GINGIVITIS. XV. BACTERIAL INFECTION AND PROTOZOAL INFESTATION AS A BASIS FOR CORRELATING ALL TYPES OF GINGIVAL INFLAMMATION

Robert A. Keilty, M.D., Mary A. Keilty Research Memorial, Washington, D. C.

The paper presented the rôle of the bacteria and protozoa—found by smear, culture and histological section—in the causation of inflammations in the structures about the teeth, and stressed their importance as a basis of correlating these inflammations, thus definitely linking pyorrhea and Vincent's disease as gingivitis. The paper included a definition of the author's pathological interpretations, and the dictum that the bacteriological flora and protozoal infestations of the gingival sulci are the prime etiological factors in all inflammations in the structure about the necks of teeth. On this basis Vincent's disease as an acute gingivitis and pyorrhea alveolaris as a chronic gingivitis are one and the same thing, with differences merely in intensity of the reactions. A method of study and report for each case, which gives an opportunity to comparative results, was briefly outlined.

24. EXPERIMENTAL ORAL LESIONS IN RATS

Mary Caldwell Agnew, M.A., R. Gordon Agnew, B.A., D.D.S., F.I.C.D., and Frederick F. Tisdall, M.D., F.R.C.P.(C), Department of Pediatrics [under the direction of Alan Brown, M.D., F.R.C.P.(C)], and the Department of Periodontology, Faculty of Dentistry, University of Toronto, Toronto, Canada

Attention was drawn to this subject by work done by two of the authors at Peking Union Medical College under the Rockefeller Foundation in 1927–28. Results on white rats suggested that diet is a very important factor in tooth formation, and a possible means of caries production. A considerable amount of material is in preparation for the histological examination now in progress. The animal laboratory is situated in the basement, with artificial light and ventilation. The animals are placed on experimental diets at one month of age. We have been successful in producing caries with the following diet (No. 40, parts per 100): whole corn (finely ground), 78.4; wheat gluten, 20.6; NaCl, 1.0; supplemented with 0.5, 1, 1.5 or 2 parts of calcium carbonate. In each of 38 rats on this diet for from 2 to 6 months, typical carious lesions were found. We have also found caries in animals on the following diet (No. 8; parts per 100): casein (alcohol extracted), 18.0; salt mixture (Osborne and Mendel, without Ca or P), 2.5; $CaCO_3$, 1.5; cornstarch, 62.0; NaCl, 1.0; Crisco, 10.0; yeast (dry, powdered), 5.0; fresh spinach, 100 grams per animal per week, or machine-dried alfalfa, 2 percent. The histopathologic examination, involving ground and decalcified sections, showed typical dental caries, backward decay of enamel, pipe-stem tubules, liquefaction foci, coalescence of foci, defence mechanism of pulp (secondary dentine), etc. The macroscopic and microscopic lesions resemble so closely the recognized carious lesions in human teeth as to warrant the assumption that the processes are analogous to human caries.

So called erosion has been regularly developed by the following diet in animals between 6 and 13 months of age (No. 10; parts per 100): casein (alcohol extracted), 18.0; salt mixture (Osborne and Mendel, without Ca or P), 2.5; cornstarch, 62.0; NaCl, 1.0; Crisco, 10.0; yeast (dry, powdered), 5.0; phosphorus added in the form and proportion in Osborne-and-Mendel salt-mixture; fresh spinach—100

gms. per animal per week, or machine-dried alfalfa, 2 percent. The erosion process was so marked, in some cases, as to expose the pulp chamber and cause necrosis of the pulp. It was less extensive when vitamin D was added in the form of Viosterol (2 percent 1D). Faulty calcification of dentine, cementum, and bone, was regularly observed for Diet No. 40 from the ages of 2 to 3 months. Advanced periodontal lesions were seen in animals on diets which produced the erosion—No. 10, and No. 40 with 0.5 percent of $CaCO_3$.

A few animals have been given the following diet (No. 17; parts per 100): casein (alcohol extracted), 18; salt mixture (Osborne and Mendel), 40; cane sugar, 62; NaCl, 1; Crisco, 10; yeast (dry, powdered), 5; with 2 percent machine-dried alfalfa. No caries has been found by histological examination between the ages of 3 months to 1 year. No histological evidence of caries was found in 16 animals from ages 3 to 15 months on normal stock diet (No. 1; parts per 100): whole wheat (ground), 60; casein (commercial), 14; whole milk powder, 10; $CaCO_3$, 1.2; NaCl, 0.8; alfalfa (machine dried), 1; butter, 8; wheat germ, 5; supplemented by 10 gm. of lean beef and 40 gm. of fresh lettuce per animal per week. In 111 animals on the same diet (No. 1), and examined under the dissecting microscope, there was no evidence of caries. In 41 animals on Diet No. 1, plus 10 percent or 20 percent 1D Viosterol, there was no histological evidence of caries between the ages of 7 to 13 months. In 35 animals on a control diet (No. 5; parts per 100)—casein (alcohol extracted), 18; salt mixture (Osborne and Mendel), 4; cornstarch, 62; NaCl, 1.0; Crisco, 10.0; yeast (dry, powdered), 5.0; with 1 and 2 percent 1D Viosterol added—there was no histological evidence of caries between the ages of 6 to 13 months.

25. THE EFFECTS OF DIETS CONTAINING ADDITIONS OF FLUORINE ON THE JAWS AND TEETH OF SWINE AND RATS

R. M. Bethke, Ph.D., C. H. Kick, M.S., Ohio Agricultural Experiment Station, and T. J. Hill, D.D.S., and S. W. Chase, Ph.D., School of Dentistry, Western Reserve University, Cleveland, Ohio

The effects of diets containing additions of F on the teeth of swine and rats are evidenced by hypoplasia of the enamel and dentin. The severity of the hypoplasia is proportional to the amount of F ingested,

and the form in which F was added to the diet. Of the four forms in which F additions were made, in dosages of equivalent F content, CaF_2 produces the least, and NaF the greatest, deleterious effects on the teeth. Rock phosphate and phosphatic limestone produce approximately the same effects, which are intermediate between those of CaF and NaF. No significant departure from the normal size or proportions of the skull were found in rats that received diets containing high levels of F. In swine, on diets containing rock phosphate or NaF, the mandibles exhibited a material increase in thickness and in the size of the medullary spaces; there was also coincident increase in the width of the dental arch.

26. OCCURRENCE OF ENAMEL TUFTS

Theodore B. Beust, D.D.S., M.D., F.A.C.D., School of Dentistry, University of Louisville, Louisville, Ky.

Investigation of the morphology and distribution of the enamel tufts shows that some current views of the structure of the enamel are misleading and erroneous. In cross sections of the enamel rods, the inner regions of the enamel are divided into parallel compartments by the segmented rows of fibrils which, in cross sections of teeth, present the image of the tufts. Photomicrographs in natural colors show that these fibrils, in youth, are permeable to stains introduced into the pulp cavity. (To be published in the *Journal of Dental Research.*)

27. TECHNIC FOR MEASURING SMALL CHANGES IN ALVEOLAR ARCHES

Frederick Lester Stanton, D.D.S., College of Dentistry, New York University, New York City

One phase of the special child research at New York University is a study of normal and abnormal alveolar growth-changes over a period of 15 years. Measurements are made on yearly casts from plaster impressions of the same individuals. While very valuable data might be obtained by simply using linear measurements, a method was sought whereby not only the linear distances could be accurately determined, but also the relative changes evaluated. The yearly casts are orthographically projected. (For the mapping technic consult our "Description of three instruments for use in orthodontic and cephalometric investigations, with some remarks on map construction:" *Journal of Dental Research*, 1931, xi, p. 885.) Central

points in the individual tooth areas are selected and these points are determined in all future surveys. Determination of the geometric center of the tooth centroids is followed by that of the axis of least asymmetry, which always passes through the centroid of the denture. In order to determine the relative changes of the tooth centroids due to growth changes during the year, it is necessary correctly to relate the yearly maps. This is accomplished by registering each map by means of denture centroids and the axes of least asymmetry, and drawing a composite map. Thus the final graph contains fifteen forms of the alveolar arch, together with paths of movements of the teeth as represented by spatial changes of the tooth centroids.

Theory of map placement. We have in space a group of points (tooth centroids) arranged in a more or less symmetrical way. A year later, owing to growth changes, we have a slightly altered spatial position of the same points. The formula for relating maps is based on the theory of "least squares," for it seems reasonable to assume that the growth forces acting on the teeth as a group have so displaced them that the sum of the squares of displacement is a minimum.

VI. Fourth Session: Morning, March 20; Abstracts 28–36

28. Tissue tolerance to foreign materials

U. G. Rickert, M.A., D.D.S., F.A.C.D., and C. Merle Dixon, D.D.S., School of Dentistry, University of Michigan, Ann Arbor, Mich.

We became interested in this study because we wanted to determine (a) what substances, if any, would be tolerated without inflammation by the vital tissues, and (b) to what extent permeability of the substances influenced irritation. These matters have important bearings on the selection of root-filling substances. The following materials were used: gutta-percha, soft wood, hard wood, bone, amalgam, gold, silver wire, lead, a root sealer, copper amalgam, pure silver, silicate cement, glazed and unglazed porcelain.

Preparation of foreign body.—All implants were made as nearly the same size as possible: 0.5 to 0.75 cm. long and 0.2 to 0.1 cm. wide. They were smoothed and polished throughout, especially on the ends, to avoid as far as possible any mechanical irritation. *Sterilization.*—Dry heat, 160° to 170°C., 1 hour; or, when impracticable, alcohol, 70 percent, 20 minutes. *Skin implantation.*—The earlier work was

done on rats, but rabbits have been used for two years. The backs of the rabbits were shaved and sterilized in the usual manner prior to operation. A 2-percent solution of novocain was used as a local anesthetic at the various positions selected for insertion of the foreign bodies. Four to six foreign bodies were placed on either side of the spine. Gross observations were frequently made until the date of posting. *Muscle implantations.*—The gluteal muscles on either side of the spine were chosen. Sodium amytol was used as the general anesthetic. From four to six foreign bodies were placed in each muscle. The aseptic technique employed in the skin work was also used here. The incisions were sutured, dressed, and frequently observed until a clear scar-formation was present at the point of incision. Thirty-five rabbits were used for the experiments conducted during 1930–1931, in which 175 implants were made. One hundred of these were the foreign bodies mentioned above; the remaining seventy-five were implantations of teeth, the results of which are not yet complete. The average time the foreign bodies remained in place before autopsy was 5.5 months. The criteria for the various degrees of inflammatory reactions used in classifying the reactions were these: 0 = no microscopic evidence of reaction; 1 = chronic productive-inflammation; 2 = chronic productive-inflammation, with foreign-body giant-cell reaction; 3 = chronic productive-inflammation, with active phagocytosis; 4 = active chronic-inflammation; 5 = chronic purulent-inflammation.

Summary. Observing in our earlier work that the cementum of the apical third of the root was more permeable than the gingival third, we suspected that some of the periapical changes not in evidence in the gingival third could be accounted for by this permeability. The wooden implants were improvised for the test. Woods of different degrees of permeability, as observed under the microscope, were used for the experiment. Our results showed that the soft woods (the most porous) produced the greatest degree of irritation—active chronic inflammation, degree 4. There was one exception—a brand of gutta-percha points, extensively used in root surgery, showed active chronic inflammation with phagocytosis bordering on the purulent stage—a more extensive reaction than soft wood. Why this brand of gutta-percha showed a greater degree of irritation—degree 4—being less porous and also quite insoluble, we are unable to explain. Amalgam,

gold, silver wire, and lead all gave much milder irritative reactions. Lead was the least irritating of the metals, causing chronic productive-inflammation with giant-cell reaction, degree 2. So far, only one plastic root-filling material has been tested. It caused no productive or cellular inflammation, showing that it was inert.

29. PHOSPHORUS METABOLISM. IV. THE PHOSPHORUS OF SALIVA, WITH SPECIAL REFERENCE TO DENTAL CARIES

Guy E. Youngburg, M.S., Ph.G., Ph.D., Medical School, University of Buffalo, Buffalo, N. Y.

Of the P in the saliva of normal persons, persons with dental caries, and nephritics, 96 percent occurs as inorganic P, which increases with age, and varies for the same individual at different times of the day and on different days. Salivas from cases of dental caries are not appreciably different in P content from normals, but greater variations are shown. Average values (P per 100 cc.) are: normals 17.5 mg.; dental caries 18.1 mg.; and nephritics 17.5 mg. There is no reason to believe that the P in saliva plays any rôle in dental caries. (Published in the *Journal of Dental Research:* 1932, xii, p. 267.)

30. LEPTOTHRIX VARIETIES IN THE MOUTH

H. T. Knighton, D.D.S., and B. G. Bibby, B.D.S., Rockefeller Fellows in Dentistry, School of Medicine and Dentistry, University of Rochester, Rochester, N. Y.

Many entirely dissimilar organisms pass under the name of Leptothrix. Some of these are probably bacteria, some are fungi. Attempts to cultivate and classify the oral types were reported. It was pointed out that none of the described oral forms can be included in the genus Leptothrix as given in the most recent classification of microörganisms, but probably all belong to the genus Leptotrichia.

31. HARDNESS TESTS ON TEETH

Harold Carpenter Hodge, M.S., Ph.D., Rockefeller Fellow in Dentistry, School of Medicine and Dentistry, University of Rochester, Rochester, N. Y.

Hardness measurements on enamel and dentin were made with the following hardness testers: Brinell, Rockwell, Shore Scleroscope,

Monotron, Herbert Pendulum, and Microcharacter. The effect of each test on tooth tissue was illustrated. There was qualitative agreement in the data for relative hardness for enamel and for dentin. (To be published in the *Journal of Dental Research.*)

32. RÔLE OF PLAQUES IN DENTAL CARIES

Edward C. Dobbs, D.D.S., Rockefeller Fellow in Dentistry, School of Medicine and Dentistry, University of Rochester, Rochester, N. Y.

Attempts to produce artificial plaques on extracted teeth were successful. Drying and bacteria denature mucin from a viscous fluid to a firm gel. It is this denatured mucin that binds food debris to the teeth, forming the dental plaque. Diffusion experiments demonstrated that plaques are only slightly permeable to electrolytes, prohibiting the saliva or alkaline mouth washes from neutralizing the acids that produce caries. Soluble carbohydrates diffuse slowly through plaques, and therein can be changed to acids, continuing decalcification after the food material in the plaque has been fermented. (To be published in the *Journal of Dental Research.*)

33. PREPARATION OF CAVITIES BY SLICE AND BOX METHODS: COMPARISON OF TOOTH SUBSTANCE INVOLVED

W. L. Wylie, B.S., D.D.S., and J.R. Yant, D.D.S., School of Dentistry, Western Reserve University, Cleveland, Ohio

Areas similar in size and location, and presumed to be typical of the susceptible areas, were defined on both mesial and distal surfaces of each of two upper first-bicuspid plaster-models of 5.5 diameters. A mesio-occluso-distal preparation of such extent as to include the susceptible areas was made in these models, one being of the box type, another of the slice type. Variations between the two preparations were considered from the standpoint of (a) amount of tooth substance lost; (b) extent of cavity margins; (c) distance of the preparation from the long axis of the tooth. The loss of tooth substance in the box preparation was 14.79 percent; in the slice preparation, it was 13.31 percent. The margin of the slice preparation was 6.71 percent greater than that of the box type.

In the mesial part of the preparations the axial walls were found to lie the same distance from the long axis of the tooth. The axial wall of the slice preparation on the distal was 12.84 percent nearer the long axis of the tooth than the corresponding wall of the box preparation.

34. A HISTOLOGIC STUDY OF SCLEROTIC BONE IN THE JAWS, WITH A CONSIDERATION OF ITS CLINICAL SIGNIFICANCE

James L. Zemsky, D.D.S., Department of Oral Histology and Embryology, Dental School, Columbia University, New York City

There are two types of sclerotic bone of which one is pathologic, showing definite signs of inflammation. The other, physiologic, presents no such evidence. Pathologic sclerotic-bone, termed *sclerotic osteitis*, is associated with a pathological process in the jaws where the sclerotic bone is located. There are two varieties: *sclerotic osteitis* and *dental osteitis*. *Sclerotic osteitis* presents signs of inflammation extending beyond the mass of sclerotic bone. *Dental osteitis* is characterized by the presence, in the specimens, of rarefying osteitis and condensing osteitis side by side. *Physiologic sclerotic-bone*, or true osteo-sclerosis, presents a dense bone-structure, which shows no sign of inflammation, and is found on either the buccal or lingual cortical bone. At times the two may become confluent. Further study might reveal various other types of osteo-sclerosis beyond the scope of the present report. The clinical significance of this structure cannot be determined by histological study, but must be based on extensive clinical investigations. (To be published in the *Journal of Dental Research*.)

35. COPPER AMALGAM PRODUCED FROM INGREDIENTS IN AQUEOUS SOLUTION

F. C. Husband, D.D.S., L.D.S., Toronto, Canada

Responding to the need for a method of filling inaccessible canals with a disinfecting amalgam, and appreciating the special value of copper amalgam in this relation, the author devised a procedure for this purpose involving the deposition of copper hydride from an aqueous solution of (a) copper sulphate by the reducing action of (b) hypo-

phosphorus acid, and an amalgamation of the copper from the copper hydride with mercury from a solution of (c) mercuric chlorid. The finely divided antiseptic copper amalgam thus produced can be precipitated in all parts of inaccessible root canals by proper introduction of the solutions mentioned and as described in the paper, where additional utilities and details are indicated, and the assurance is given that the proposed use of these solutions does not have a deleterious influence on the related tissues. (Published in the *Journal of Dental Research*, 1932, xii, p. 321; April.)

36. ORAL RELATIONS OF AGRANULOCYTOSIS

Thomas J. Cook, D.D.S., Dental School, University of Pennsylvania, Philadelphia, Pa.

Little is known of the etiology of agranulocytosis. It is usually of acute onset, accompanied with fever, chills, and malaise. Blood examinations show that the red blood-cells are about normal, white blood-cells greatly reduced in number, polymorphonucular leucocytes greatly decreased, lymphocytes, increased. Although some investigators regard agranulocytosis as a symptom rather than a disease, nearly all agree that the condition is accompanied by lesions in the mouth, while the tonsillar region and pharynx become injected and necrotic. Lesions in the mouth may appear on the palate, alveolar ridges, lips, and cheeks, and are not unlike an acute Vincent infection, but smears from these ulcerated areas do not contain the organisms demonstrable in Vincent's infection. Two cases are presented in this report, because of the contrast in the treatment and the results.

Case 1.—Case diagnosed as agranulocytosis and treated carefully for over a year. Examination revealed several teeth believed to be serving as definite foci of infection; also infected tonsils. Oral and throat lesions were treated with variety of drugs until condition was considered well under control; tonsils then removed. Short time later necessary teeth were removed without exacerbation. Patient got well under medical treatment; no recurrence for over a year. *Case 2.*—Patient came to hospital with condition diagnosed as agranulocytosis, attack having been precipitated by extraction of several teeth. No

preliminary preparations were made. Lips and oral mucosa ulcerated; tongue, swollen and red. Patient died five days after admission.

VII. Fifth Session: Afternoon, March 20; Abstracts 37–48

37. localization of trichinella spiralis in mouth

Thomas J. Cook, D.D.S., Dental School, University of Pennsylvania, Philadelphia, Pa.

Trichinosis is well known to the medical profession the world over. From time to time there appear in medical literature reports, by various observers, that from one to ten persons have been infected by eating insufficiently cooked pork. Usually the victims are among those eating in boarding houses. For this reason swine killed in abattoirs are searched for trichinae by workers for boards of control of food products. Trichinella spiralis, which is essentially a parasite of swine, can live in rats, mice, rabbits, and many other animals, as well as in man. It carries out its whole life-cycle in one animal, but must pass into the digestive tract of another animal to begin another life cycle. It is from eating insufficiently cooked pork that man is infected, but pigs are often infected from eating dead rats. The embryos, both male and female, are found in the muscle substance of the pig, and on being eaten by man quickly develop into mature forms when they reach the intestines. The females, when liberated in intestines, penetrate the villi and are carried to all parts of the body, but usually choose the voluntary muscles for their permanent abode. The parasite coils itself up and becomes surrounded by a thick hyaline capsule, which is completely or partially calcified, and within which the worms may live for years in these muscles awaiting a chance to go through the development in their turn, in the body of another animal. Many investigators, including Keilty, believe that the masseter muscle is often the residence for these encapsulated trichinæ. In the case reported here—the discovery of which as in many similar instances was accidental—on clinical examination a small mass was disclosed in the mouth of a patient who, nine years before, suffered from trichinosis. On microscopic examination the diagnosis of Trichinella spiralis was confirmed.

38. PYORRHEA ALVEOLARIS; HISTOPATHOLOGY AND RESULTS OF RADICAL SURGICAL TREATMENT—A PRELIMINARY REPORT[9]

James B. Mann, D.D.S., Major, Dental Corps, U. S. Army, Arthur B. Crane, D.D.S., and Harry Kaplan, D.D.S., Washington, D. C.

In attempting to determine the results of radical surgical treatment of pyorrhea alveolaris, blocks extensive enough to keep intact all tissues involved were removed from 35 living cases, before or at intervals after surgical treatment.

Pathological findings in untreated cases. There is extensive variation in the depth of the pockets surrounding individual teeth, and also approximating teeth in the same mouth. All pockets examined have shown calculus in varying amounts on the teeth, and more or less purulent exudate. The surface epithelium, and that lining the gingival crevices, show hyperplasia, extensive degeneration, and ulceration, which are attributed to irritation, both mechanical and bacterial, as well as to an altered blood supply and *inflammatory* reaction in the underlying tissues. In many cases there is also present degeneration, with cystic formation in the epithelial proliferations into the underlying tissue. Subepithelial changes are characterized by heavy monocytic infiltration, with destruction of the superficial groups of the principal fibers of the peridental membrane, extensive absorption of the cementum, necrosis, and granulation-tissue formation. The blood vessels in these areas show varying stages of obliterating arteritis. Changes in the alveolar bone are very marked, and there is early and extensive inflammatory reaction in the marrow spaces. Osteoclasts are often present, and there is extensive destruction of the bone, with sequestration and marked fibroblastic proliferation.

Findings in operated cases. Blocks taken immediately after operation show complete removal of pathological tissue. In the healed cases the blocks show complete regeneration of the epithelial covering of the gum, and by its attachment to the cementum a new gingival crevice is formed. The new crevices are of ideal type, less than 1 mm.

[9] The histologic work was done in the Laboratory of Dental Pathology, Army Medical Museum, Washington, D. C. To be published in the *Journal of the American Dental Association.*

in depth. The alveolar bone has a dense cortical layer such as is normally present in well-formed alveolar bone showing no pathological changes. Differential staining shows that there is not only a new formation of the principal fibers of the peridental membrane at this lower level, but also reorganization of these fibers into free gingival, transeptal, and alveolar-crest groups, such as are present in normal cases. From a histopathological standpoint the success of this operation seems to depend on thorough removal of infected tissue, and on leaving a remainder of normal tissue sufficient to give the tooth reasonable support.

39. RADIOGRAPHIC STUDY OF THE ROOT CANALS OF HUMAN TEETH

Augustus H. Mueller, D.D.S., B.S., Chicago College of Dental Surgery, Loyola University, Chicago, Ill.

In a study of the anatomy of the root canals of extracted human teeth, a total of 1394 incisors, cuspids, and bicuspids of the permanent dentition were used. Each tooth was radiographed in the usual labio-lingual or bucco-lingual direction, and also in the mesio-distal direction. These two radiographs of each tooth, when compared, showed a decided difference between the usual conditions seen in the radiographs of teeth in situ and in the mesio-distal view. Many teeth that, in the bucco-lingual radiograph, appeared to have single straight root-canals revealed, in the mesio-distal direction, various irregularities and ramifications of the canals.

40. CHANGES IN DENTIN AND PULP PRODUCED BY CARIES AND DENTAL RESTORATIONS

Warren Willman, D.D.S., B.S., Chicago College of Dental Surgery, Loyola University, Chicago, Ill.

Our study tends to show that regressive or evolutionary changes occur in nearly all human pulps with advancing age, without relation to outer irritations. Denticle formation, sclerosis of the dentin, vacuolar degeneration of the odontoblasts, reticular atrophy of the pulp, and formation of connective-tissue cysts of the pulp, are the changes most often found. The localized deposition of secondary

dentin seems to be the only reaction that invariably follows external irritation, whether by abrasion, erosion, caries, or dental restoration.

41. RADIOGRAPHIC AND MICROSCOPIC FINDINGS IN PULPLESS TEETH COMPARED

E. P. Boulger, D.D.S., L.D.S., Chicago College of Dental Surgery, Loyola University, Chicago, Ill.

Pulpless teeth that had been filled for periods varying from months to years were radiographed, extracted, and studied microscopically. Particular care was taken to secure those teeth that disclosed minute indications of bone resorption in the radiographs, and also those that appeared normal from a radiographic standpoint. When definite evidence of bone resorption appeared in the radiograph, this was substantiated in the microscopic slides. When the radiographic indications were doubtful, the microscopic evidence was variable—in some instances, the root-end appeared to be well healed-in; in others, there were definite manifestations of inflammation.

42. DENTAL STRUCTURES IN OVARIAN CYSTS

Rudolf Kronfeld, M.D., Chicago College of Dental Surgery, Loyola University, Chicago, Ill.

Dental structures frequently occur in dermoid cysts of the ovary. These teeth usually have crowns similar to normal crowns with well-formed enamel, dentin, and pulp; the roots, however, are short and poorly formed, and frequently in solid junction with bone in the wall of the cyst. Resorptive processes are very common. In some instances, the greater part of a tooth is destroyed by resorption and replaced by cancellous bone. In the enamel, lamellae extending into the dentin are present. In the pulp, secondary dentin and calcifications (denticles) are found. The epithelial lining of the cyst cavity is united with the enamel surface by a typical epithelial attachment. The tissue at the bottom of the gingival crevice shows very marked round-cell infiltration, similar to that found in corresponding areas in the oral cavity.

43. THE MINUTE ANATOMY OF THE CHILD'S FACE, JAWS, AND RELATED STRUCTURES, AND ITS BEARING ON PLASTIC SURGERY

William H. G. Logan, D.D.S., M.D., M.S., LL.D., F.A.C.D., F.A.C.S., Dental School, Loyola University, Chicago, Ill.

The report was opened with a review of a few slides from the material presented last year before the Association, which outlined the position of the deciduous and permanent tooth-germs in children from birth to six months of age. (*Journal of Dental Research*, 1931, xi, p. 488; June.) A statement of the value of a study of the relation of the mandible to the maxilla and all the related soft structures to these bones was outlined. To fulfill such a need, human material (of children) was secured, and sections of these jaws, together with all their investment soft-tissues, were shown. The specimens presented an opportunity to study the relationship of nose, lips, and cheeks to the supporting bone, as well as the direction of the muscle fibers in these structures; and with equal clearness, the muscles forming the floor of the mouth and of the tongue. The presentation included the organs of the oral cavity—tongue, hard- and soft-palate, parotid, submaxillary and sublingual glands, and lymphatic tissue, as well as pharynx, larynx, and esophagus—which could be visualized in their undisturbed topography.

44. STUDIES, IN THE RAT, OF SUSCEPTIBILITY TO DENTAL CARIES. II. THE EFFECT, ON MOTHERS AND YOUNG, OF DIETS DEFICIENT IN CALCIUM AND VITAMIN D, DURING PREGNANCY, LACTATION, AND REARING[10]

Theodor Rosebury, D.D.S., and Genevieve Foley, A.B., M.A., Department of Bacteriology, College of Physicians and Surgeons, Columbia University, New York City

Eighteen normal adult female rats were distributed among four groups, under the following dietary conditions, respectively: diets with a slightly deficient (approximately 2:3) Ca:P ratio, and viosterol in (a) zero, (b) subminimal, and (c) optimal dosage, and (d) a modified McCollum stock diet. These were mated to normal males, and

[10] Conducted with the aid of a grant from the Commonwealth Fund for research in dental caries.

carried through pregnancy and lactation, and some for a period of three months thereafter, under the same conditions. All the young from mothers on the viosterol-free diet died within 24 hours after birth. The other litters were distributed at weaning among the three remaining diets and various modifications of them (involving addition of gum-tragacanth powder for adhesiveness, sodium carbonate to stimulate production of salivary mucin for the same purpose, and carbohydrate—glucose—excess). Those that survived were carried on the diets for a period of 100 days after weaning. Sections were prepared from the jaws of all mothers and young, and from the tibias of a representative group. Growth curves of the mothers, during lactation, indicated marked loss in weight in the low-viosterol group; slight loss in the optimal-viosterol group; and slight gain in the stock-diet group. The young from stock-diet mothers on stock- or optimal-viosterol diets, and those from optimal-viosterol mothers on the stock diet, showed optimal growth curves. The remainder suffered varying degrees of retarded growth; although even the poorest groups (animals born and reared on the low-viosterol diets) gained weight consistently. The optimal-viosterol (low-Ca) diets induced retardation of growth only when fed to animals from mothers on the same or on the low-viosterol diets.

Beginning disintegration of the dentin at the summit of the molar cusps was found in 3 mothers and 7 young, so distributed among the groups that no correlation with experimental conditions was possible. This finding has been noted previously[11] and is not considered analogous to human dental caries. Otherwise no caries or caries-like lesions developed.

A number of the conditions widely held accountable for dental caries have been tested in this and the preceding investigation,[12] including soft adhesive diets; diets rich in fermentable sugar; diets containing actively acidogenic lactobacilli; and diets deficient in vitamin C; also in Ca and vitamin D—the last having been severe in degree in young rats, and mild in degree continuously during prenatal and postnatal life. Evidence of the impaction of food in the fissures of the molars, and of the presence in the rat mouth of aciduric bacteria, has been

[11] Rosebury: *Journal of Dental Research*, 1932, xii, p. 255.
[12] Rosebury and Karshan: *Ibid.*, 1931, xi, p. 121.

found. Since it is now clear that young rats are susceptible to dental caries, of a type similar to the human lesion (see abstract, below), these negative findings assume added significance. It seems reasonable to conclude that these conditions, alone and in the various combinations tested, are either not at all responsible for dental caries, or require, in addition, some factor or factors not included in these experiments.

Pathological changes in these animals, chiefly alterations in calcification of the teeth and bones, well correlated with the experimental conditions, will be described in the complete report.

45. STUDIES, IN THE RAT, OF SUSCEPTIBILITY TO DENTAL CARIES. III. PRODUCTION OF EXPERIMENTAL ENAMEL CARIES IN YOUNG RATS[13]

Theodor Rosebury, D.D.S., Maxwell Karshan, M.A., Ph.D., and Genevieve Foley, A.B., M.A., Departments of Bacteriology and Biological Chemistry, College of Physicians and Surgeons, Columbia University, New York City.

Following the line of reasoning previously expressed,[14] a group of 22 normal rats were placed at weaning (22 days after birth) on a diet, intended to reproduce the conditions reported by Shibata,[15] as follows: unground brown-rice, plus 8 percent of white-potato dextrin; and 5 grams of fresh spinach leaves per rat per day. Acting on information available when these experiments were started,[16] the animals were divided into two groups, one of which received water *ad lib*, the other no water other than that on the spinach leaves (which were washed and drained before feeding). These animals were killed in pairs at weekly intervals after having been on the diets 20 days. All animals in both groups, killed after 33 days on the diets, showed changes in the enamel at the base of the molar fissures—seen in ground sections as yellowish or brown discoloration. Radiographs show definite loss of

[13] Conducted with the aid of a grant from the Commonwealth Fund for research in dental caries.

[14] Rosebury: *Journal of Dental Research*, 1932, xii, p. 255.

[15] Shibata: *Japanese Journal of Experimental Medicine*, 1929, vii, p. 247.

[16] Personal communication from Prof. M. Shibata to Prof. E. C. McBeath, Dental School, Columbia University, dated March 3, 1930.

opacity at these points, extending into the dentin. Celloidin sections show penetration of the dentin in the same regions, with no secondary-dentin formations in the path of the lesions. This lesion thus appears to fulfill the three criteria of true dental caries previously enumerated; namely, it must (a) begin in enamel, (b) occur in relatively young animals, and (c) progress with relative rapidity. Another condition in many instances was fracture of the molar cusps, particularly the large subdistal cusp of the lower first-molar, leading to exposure of the pulp and abscess formation; and later, by continued fracture, to the formation of a large open cavity in the tooth. This condition, although accompanied by secondary infection of the dentin, resulting in tissue changes similar to or identical with caries of dentin in human teeth, should be sharply distinguished from true dental caries.

Since obtaining these results we have received from Prof. Shibata decalcified sections of the lesions produced in his experimental rats, and a sample of the rice he used. These sections show lesions at the base of the molar fissures similar to those reported here. They are more extensive, however, and more widespread over the three teeth, perhaps owing to a longer experimental period, the thickness of the molar dentin in these sections suggesting older animals than any of ours so far examined. These sections show, as well, only very slight indications of pathological calcification of the dentin, whereas our own animals showed marked changes. Comparative analyses of the rice used by Shibata—a crude product, containing much extraneous material—and that used by us, offer an explanation for this difference. Shibata's rice contained 380 mg. of Ca and 595 mg. of P per 100 gm. The rice used by us contained 9 mg. of Ca and 267 mg. of P per 100 g.

The diet used in these experiments is markedly deficient in mineral salts and protein; but, in view of our previous negative findings (I and II in this series), and the recent experiments of Hoppert, *et al.*,[17] we doubt that these conditions are important in the etiology of this lesion. It seems premature, however, to draw any conclusions from this work except that enamel caries, of a type similar to human caries, may be produced in the rat. Further experiments are under way to determine the causative factors involved.

[17] Hoppert, Webber, and Canniff: *Journal of Dental Research*, 1932, xii, p. 161.

46. RECENT STUDIES IN THE CONTROL OF PERIAPICAL INFECTION

Louis I. Grossman, D.D.S., D.M.D. (Rostock), Dental School, University of Pennsylvania, Philadelphia, Pa.

Root-canal therapy aims to eliminate infection in the pulp canal and especially in the periapical region. Assuming that such infection is eliminated and the tissues are rendered sterile, do the tissues remain sterile? The methods presented here are intended to determine this from a bacteriologic standpoint. In addition, these methods of control may be used to check a particular method of root-canal therapy. The same methods may also be applied to teeth suspected of being possible foci of infection. Such teeth need not be sacrificed when negative cultures are obtained. The intradental method is simple, and expedient in most cases; but from a large sector of the periapical region, material for culture may not be obtainable. This method cannot be used in narrow or tortuous canals, or where the root canal filling cannot be removed. Apicostomy gives a direct approach to the periapical region, and requires only a simple surgical technic, but the method is as yet insufficiently controlled. Root amputation unquestionably provides the best approach to the apical tissues, but requires skilled surgical technic and assistance. In addition few patients submit to this operation for the purpose of investigating the condition of the periapical tissues.

47. ELECTROLYTIC THERAPY IN TREATMENT OF PERIAPICAL INFECTION

R. Werther, D.D.S., and J. L. T. Appleton, Jr., B.S., D.D.S., School of Dentistry, University of Pennsylvania, Philadelphia, Pa.

Using the number of treatments needed to obtain a negative culture as an admittedly imperfect, but at present indispensable criterion of the relative values of two methods of treating periapical infection [(1) camphorated monochlorophenol topically applied, and (2) electrolytic therapy with a zinc iodid-iodin solution], we reach the conclusion that the second method is preferable. Cases that had repeatedly yielded positive cultures (persistence of infection) promptly gave negative cultures after the institution of electrolytic therapy. The preliminary topical treatment did not seem to contribute to the promptness with which these negative cultures were obtained. Certain cases, for which topical medication was strongly contra-indicated

by past clinical experience, readily gave negative cultures when treated by electrolytic therapy.

48. THE VALIDITY OF THE BACTERIOLOGIC CONTROL OF THE TREATMENT OF PERIAPICAL INFECTION

J. L. T. Appleton, Jr., B.S., D.D.S., and O. G. L. Lewis, D.D.S., School of Dentistry, University of Pennsylvania, Philadelphia, Pa.

Hitherto the bacteriologic control of the treatment of periapical infection has been urged on general grounds. In recent months some evidence bearing specifically on this procedure has come to light. (1) The percentages of positive or negative cultures obtained after successive treatments do not correspond with the percentages to be expected if the securing of a positive or negative culture were a matter of mere chance. This finding indicates that the culture does in some degree reflect the bacteriologic condition of the root-canal or the periapical tissues. (2) An analysis of the data of Rhein, Krasnow and Gies (*Dental Cosmos*, 1926, lxviii, p. 971) clearly shows that a clinically and roentgenographically satisfactory result is much more likely to follow when a canal is filled only after a negative culture is obtained, than when the canal is filled in spite of a positive culture.

VIII. SIXTH SESSION: EVENING, MARCH 20; ABSTRACTS 49–53

(Including annual dinner and annual business session)

49. PRESIDENT'S ADDRESS: THE VALUE OF RESEARCH IN DENTISTRY

A. E. Webster, D.D.S., M.D., L.D.S., F.A.C.D., Faculty of Dentistry, University of Toronto, Toronto, Canada

Published in full on pages 412–414.

50. CHILDREN'S FUND OF MICHIGAN RESEARCH ON DENTAL CARIES, IN THE LABORATORIES OF THE SCHOOL OF DENTISTRY, UNIVERSITY OF MICHIGAN

Russell W. Bunting, D.D.S., D.D.Sc., F.A.C.D., University of Michigan, Ann Arbor, Mich.

On April 11, 1929, United States Senator James Couzens, of Michigan, made a gift of $10,000,000 for the establishment of a fund to be

known as the Children's Fund of Michigan. The purpose of this fund is "to promote the health, welfare, happiness and development of the children of Michigan primarily and elsewhere in the world." This fund of $10,000,000 is administered by a Commission, the Chairman of which is Dr. Hugo Freund; the Secretary, Mr. William J. Norton. It was stipulated that the fund, interest, and principal, must be expended completely within twenty-five years from May 1, 1929. On July 11, 1929, the Commission awarded a grant of $22,000 per year for three years, and provisionally for two additional years, to promote a study in the laboratories of the School of Dentistry, University of Michigan, of the cause and control of dental caries. This grant has been administered by a committee consisting of President Alexander G. Ruthven, Dean Marcus L. Ward, and Russell W. Bunting.[18] The University provided laboratory facilities and full equipment for dental research. The grant from the Children's Fund has been utilized solely for the salaries of the research group and expenses incidental to the research. The Committee on Administration of the grant has had the coöperation of a group of consultants consisting of Dr. Howard B. Lewis, Department of Biochemistry, Dr. Philip Hadley, Department of Bacteriology, and Dr. Lewis H. Newburgh, Department of Internal Medicine, all of the University of Michigan. Dr. Newburgh has lately been succeeded by Dr. D. Murray Cowie, Department of Pediatrics.

For the conduct of this research, the coöperation of qualified workers in the allied fields of dentistry, bacteriology, nutrition and biochemistry was secured in the following personnel: *Philip Jay*, M.S., D.D.S. (Michigan), dentist and bacteriologist; formerly of the University of Rochester, Rochester, New York. *Martha Koehne*, Ph.D. (Yale), biochemist and nutritionist; formerly Professor of Home Economics, University of Tennessee. *Rebecca Hubbell*, Ph.D. (Yale), biochemist; formerly of the Florida College of Women. *Elise Morrell*, M.S. (Tennessee); formerly nutritionist, University of Tennessee. *Faith Hadley*, A.B., M.S. (Michigan), bacteriologist. *Mary Crowley*, A.B., M.S. (Michigan); formerly of the Michigan State Department of Health. Miss *Clara Raven*, M.S., and Mr. *A. Packchanian*,

[18] Dr. Bunting is the Director of the research on this grant.—[Ed.]

bacteriologists, have been employed for a limited period. *Dorothy G. Hard*, D.D.S., of the Dental Hygiene School, University of Michigan, and *W. H. MacCracken*, D.D.S., of Detroit, have given very valuable assistance, in an ex-officio capacity, in dental examinations and in the conduct of dental surveys. The activities of this research group, in the study of dental caries, have been especially directed along four phases of investigation, namely: (1) Bacteriology of dental caries, and the immunologic reactions of the body against the organisms specifically associated with the disease. (2) Biochemical differences in the blood and the saliva of caries-free and caries-susceptible individuals. (3) Diet and nutrition related to the activity of dental caries. (4) Effects of prophylactic and therapeutic measures in the control of the disease.

(1) *Bacteriology and immunologic reactions. Mrs. Hadley* is continuing her studies on the biology of the aciduric organisms associated with dental caries. Over a period of two years, she has been attempting to determine the type characteristics of B. acidophilus associated with dental caries by means of cultural, biochemical, and serological reactions. She is also making a comparative study of B. acidophilus from the mouth and intestine. Mrs. Hadley has recently formulated a standardized technique for the quantitative determination of B. acidophilus, which will facilitate very important studies of the relative activities of B. acidophilus in various types of cases, and afford a basis for a much more intelligent comparison of and differentiation between caries-free and caries-susceptible individuals than has heretofore been possible. *Dr. Jay* and *Miss Crowley*, in tests of the effect of intradermal injections of filtrates of B. acidophilus, have observed very definite skin reactions which, in many cases, correspond to the degree of activity of dental caries. This skin-reacting substance is being studied chemically and serologically, and its relation to the growth of B. acidophilus in the mouth determined. (See abstract, p. 429.) Experiments in the vaccination of caries-susceptible individuals with dead cultures of B. acidophilus are being made to observe effects on the skin reactions and the activity of B. acidophilus in the mouth and intestine. There is also in progress a very comprehensive serologic study of B. acidophilus, in which freshly isolated strains are being classified by standardized sera. Blood sera from caries-free and

caries-susceptible individuals are being examined for B. acidophilus agglutinins. This work is being conducted on patients in the Dental Clinic, on children in public schools, and on inmates of the Wayne County Training School in Northville, Michigan. *Mr. Packchanian* has been temporarily engaged, on part time, to make a detailed study of the total bacterial flora of the mouth associated with the aciduric organisms of caries. By these correlated studies of the bacteriology of dental caries, we hope to determine the relationship of aciduric organisms to dental caries, and to discover, if possible, the influences that determine why these organisms may thrive in one mouth and produce the disease, while in another are seemingly restricted or prohibited in growth. The ultimate object to be attained is the discovery of a means by which a susceptible individual may be protected from the overgrowth and activity of the caries-producing bacteria in the oral cavity.

(2) *Biochemical studies.* The chemical investigations, conducted by *Dr. Hubbell* assisted by *Mr. B. Prytz*, and other members of the group, have been confined to three specific problems, as follows: (*a*) Ca and also P determinations were made in the salivas of 75 children in the Lincoln Consolidated School over a period of 15 months. To 50 of these children milk, viosterol, and tomato juice were furnished at the school as a supplement to the home diet. The remaining 25 children were carried as controls. The object of this experiment was to determine whether, by such supplemental feeding, any appreciable change might be induced in the Ca or P of the saliva, the bacteriology of the mouth, and the activity of dental caries. In this study over 1000 salivary analyses have been made, the final report of which will be ready for publication in the near future. (*b*) More comprehensive biochemical studies have been made of a small group of children in the Social Hygiene Unit of the University Hospital, which are under the dietary supervision of the nutritional group. Analyses have been made of the blood and saliva of these children at intervals of one month, in which the pH, CO_2 capacity, P, total and diffusible Ca, and salivary amylase have been determined. Mineral-balance determinations have been made of selected individuals from this group, in which the total Ca and P intakes and outputs over a period of one week have been computed. Twenty-one such balance-weeks have been com-

pleted. (*c*) A comparative study of the blood and saliva of caries-free and caries-susceptible children is in progress to determine whether any demonstrable biochemical differences exist. Estimations are being made of the pH, CO_2 capacity, P, total and diffusible Ca, and salivary amylase.

(3) *Nutritional studies.* The dietary studies, conducted by *Dr. Koehne*, assisted by *Miss Morrell*, consist of supervised dietary experiments and demonstrations on groups of children, and nutritional analyses of patients who are either free from, or markedly susceptible to, dental caries. (*a*) Since January 1, 1931, a small group of girls in the Social Hygiene Unit of the University Hospital have been fed a prescribed diet under the supervision of Dr. Koehne. This diet is quantitatively prepared, and the amounts of food eaten are recorded. At present the purpose is to note the effect of inclusion of moderate and large quantities of sugar on the amount of other basic foods consumed, general health of the child, biochemical composition of the blood and saliva, bacteriology of the mouth and intestine, and activity of dental caries. (*b*) During the past two years a group of approximately 300 children at the Lucas County Children's Home, at Maumee, Ohio, have been fed an adequate, low-sugar diet with a resultant marked decrease in dental caries. Dr. Koehne is now making a more accurate and detailed study of the food intake of these children than was possible in the earlier study. The diet remains practically unchanged and but one variable has been introduced—some of the children receive raw fruits at the end of the meal; others, at the beginning. This is done to observe the cleansing effects of such foods. Chemical and bacteriologic surveys of these children are being made at intervals by other members of the research group. (*c*) A similar demonstration is contemplated in a group of young children in the Michigan School for the Deaf, at Flint. It is expected that this study will be begun about December 1, 1932. (*d*) Studies are being made, by other members of the group, of the nutritional, dental, and general-health histories of selected individuals, in connection with the biochemical and bacteriological studies. (*e*) A program of animal experimentation is now being organized under the direction of Dr. Koehne. A variety of diets will be fed to determine their effect on the bacterial flora of the mouth and intestine, and on the activity of dental caries.

(4) *Prophylactic and therapeutic measures.* Extension of our studies of the beneficial effects of prophylactic and therapeutic treatment of susceptible patients was deferred until a quantitative method of estimating the activity of B. acidophilus in the mouth could be devised. Now that such a method is available, extensive studies of the degree of activity of aciduric organisms in the mouth will be undertaken to determine the value of various types of prophylactic procedures. In this manner we believe that very valuable information concerning the effects of the various operative and clinical procedures, as they relate to the control of dental caries, may be obtained. This work will be carried out by the *Director* of the research, and *Mrs. Hadley* and *Dr. Hard.*

In addition to these studies, group surveys are being made to determine the prevalence of dental caries among various types of school children in public schools and in orphanages. These surveys are being made by the *Director*, and *Drs. Jay, Hard*, and *MacCracken.* During the past year we have made over 1500 accurate examinations in which was recorded the progress of dental caries over a period of one year. These examinations have been made in the public schools of Ann Arbor; Michigan Home and Training School, Lapeer; German Protestant Orphanage, and Protestant Orphan's Home, Detroit; Lincoln Consolidated School, Ypsilanti; Grosse Isle Public School; Lucas County Children's Home, Maumee, Ohio; and Michigan State Public School, Coldwater. (See abstract, p. 444).

The following reports of the researches have been published, or will soon appear, in professional journals: A report of the successful control of dental caries in three public institutions. R. W. Bunting, Philip Jay, and Dorothy G. Hard, *Journal of the American Dental Association*, 1931, *18*, p. 672; April. Further studies on the recognition of B. acidophilus. Faith Hadley and R. W. Bunting, *Ibid.*, 1932, *19*, p. 28; Jan. Preliminary studies on the immunology of dental caries. Philip Jay, Mary Crowley, and R. W. Bunting, *Ibid.*, 1932, *19*, p. 265; Feb. Calcium and phosphorus in saliva in relation to dental caries. Rebecca B. Hubbell and Russell W. Bunting (*in press*). Relationship of occurrence of B. acidophilus in humans to skin sensitivity and specific agglutinins in blood serum. Philip Jay and Mary Crowley (*in press*); see abstract, p. 429.

51. SPECIAL DENTAL CARIES RESEARCH, AIDED BY THE COMMONWEALTH FUND

Harold J. Leonard, D.D.S., B.A., School of Dental and Oral Surgery, Columbia University, New York City

In October, 1929, a plan and budget for a coördinated study of dental caries, to be undertaken by the Department of Dentistry of Columbia University, was submitted to the Commonwealth Fund of New York for consideration by their Board in December. This was an outcome of conferences previously held between representatives of the University and officers of the Fund. The plan and budget were approved and the work was officially started on February 1, 1930. The budget called for $35,600 the first year, and $32,300 in each of the two succeeding years (total, $100,200). The plan aimed to attack the problem from five angles: (1) A study of the chemical differences in oral fluids, tooth tissues and blood, as between persons or animals susceptible to dental caries, and those non-susceptible; to determine, if possible, a chemical index of susceptibility or non-susceptibility, and how chemical differences might be controlled. (2) A study of the bacteria of dental caries, any immunological principles involved, and the artificial production of caries by local bacterial means. (3) A study of the histopathology and physiology of the enamel, dentin and pulp, to determine the part that tooth structure, pulpal condition, and dental-tissue fluids might play in susceptibility and resistance to dental caries. (4) A study of the dental effects of deficiency-diet feeding-experiments on animals, to determine whether true dental caries may be caused by such feeding in otherwise resistant animals, and if so, under what conditions. (5) An attempt to render susceptible children resistant to dental caries by feeding protective diets, to determine whether resistance can be established by this means, and just what factors in the diet are necessary for protection.

These studies have been approached from the standpoint of the fundamental sciences. The research now involves directly workers in the Departments of Biochemistry, Bacteriology, Pathology, and Pharmacology, as well as Dentistry. The Advisory Board consists of *C. F. Bödecker*, Prof. of Dentistry, Chairman;[19] *H. T. Clarke*,

[19] Member of the Dental Faculty.

Prof. of Biological Chemistry;[20] *W. H. Eddy*, Prof. of Physiological Chemistry;[21] *F. P. Gay*, Prof. of Bacteriology;[20] *A. F. Hess*, research associate, Department of Pathology;[20] *J. W. Jobling*, Prof. of Pathology;[20] *H. J. Leonard*, Prof. of Dentistry, Secretary;[19] *C. C. Lieb*, Prof. of Pharmacology;[20] *Alfred Owre*, Prof. of Dentistry;[19] *A. M. Pappenheimer*, Prof. of Pathology;[20] *H. C. Sherman*, Prof. of Chemistry;[22] *P. E. Smith*, Prof. of Anatomy;[20] and *H. B. Williams*, Prof. of Physiology.[20] The research staff consists of Drs. C. F. Bödecker, Chairman; *Edmund Applebaum*, *J. D. Berke*, *S. L. Blackberg*, *L. R. Cahn*, W. H. Eddy, *Maxwell Karshan*, *Frances Krasnow*, H. J. Leonard, *E. C. McBeath*, *Theodor Rosebury*, and assistants.

A study of the bloods and salivas of carefully selected individuals who had no dental caries, in contrast with another group having active progressive caries, to determine possible relationships between non-susceptibility to caries and amounts of salivary Ca, P, H ion and titratable alkali, or of blood Ca, P, H ion, protein content, and alkali reserve, gave results that were chiefly negative. There was a slight correlation affecting salivary P, the average amount in the saliva of non-carious individuals having been somewhat higher than that of susceptibles, but there was so much variation among individuals that this correlation does not seem to be significant. The results of this study by *Drs. Karshan*, *Krasnow*, and *Krejci* were published in the *Journal of Dental Research*: 1931, p. 573; August. This study has had an important by-phase. An accurate method of determining calcium in saliva without ashing has been developed, by which a great saving of time is accomplished and the use of platinum avoided. A paper on this subject by *Drs. Krasnow*, *Karshan*, and *Krejci* is in course of publication. *Dr. Karshan* is now studying the composition of enamel and dentin under different conditions. Water extracts of pulverized enamel and dentin and the insoluble residues, have been analyzed for possible differences between caries susceptible and resistant individuals. An abstract of a report on this work is given on p. 523. *Dr. Karshan* is also collaborating with *Dr. Rosebury* in experimental dietary work to produce dental caries in rats. (See abstract, p. 464.)

[20] Member of the Medical Faculty.
[21] Member of the Faculty of Teachers College.
[22] Member of the Faculty of Columbia College.

Dr. Krasnow is developing an improved technic for fluorine determinations where the quantities are minute, as in dental tissues. She is also making a series of animal experiments on the general growth and dental effects of fluorine feeding and fluorine deprivation (see abstract, p. 532), and on the significance of variations in salivary composition (see abstract, p. 530). The staining reactions of dentin under dental caries indicate the presence of lipins (Bödecker: *Journal of Dental Research*, 1931, p. 277; April). The source of this lipin, and its significance in the caries process, is now being studied by *Dr. Krasnow*.

The work in the Department of Bacteriology has progressed along two main lines: (a) studies of the acid-producing bacteria (lactobacilli) which our own and other researches indicate as essential agents in the mechanism of dental caries; and (b) attempts to produce dental caries in rats experimentally, as a first step toward the type of systematic study of this disease that is possible only in experimental animals. *Dr. Rosebury*'s work, as well as that of others elsewhere, indicates that the initial destruction in enamel is brought about by acid elaborated from carbohydrate food by a single species or group of bacteria (lactobacilli) similar to or identical with Bacillus acidophilus. These organisms, particularly from human caries, have a capacity for producing and withstanding concentrations of acid somewhat higher than those tolerated by other organisms that actively ferment carbohydrate. Variations in strains of lactobacilli occur in respect to acid-producing and acid-resisting powers. While lactobacilli from human dental caries, from human intestines and rat mouths, in which these studies show them to be always present, are all closely related, as found in cultural and morphological studies (Rosebury and Karshan, *Journal of Dental Research*, 1931, xi, p. 121), they may be subdivided into three groups as regards their acid-producing power—the group having the strongest power contains the majority of strains from dental caries; that having the weakest, the majority of strains from rats. This study is now in press. (See abstract, p. 430.) Present information suggests that susceptibility to dental caries does not depend on the mere presence of lactobacilli in the mouth, nor on the variety of these organisms as determined by any of the methods now available. Whether the relative number of these bacteria in a given

mouth is an expression of conditions predisposing to dental caries, or a secondary manifestation of a process made possible by some other agency, is not yet clear. These studies have been facilitated by a recent adaptation of a glass electrode (devised in the Department of Biological Chemistry) that makes possible the measurement of pH in biological media with a speed, precision, and freedom from error not afforded heretofore by any other method.

In attempts to produce caries in rats, the first series of experiments involving dietary conditions that other workers have regarded as essential failed to accomplish the purpose. The dietary conditions included in the first two investigations (the first by *Rosebury and Karshan, Journal of Dental Research*: 1931, p. 121; Feb.; the second, see abstract on p. 462), were the following: (first group) Ca and vitamin-D deficiency, vitamin-C deficiency, fermentable carbohydrate (glucose) excess, soft adhesive mixture, and actively acid-producing lactobacilli from human dental caries. In the second group, an attempt was made to produce hypoplasia of the enamel of molar teeth by feeding a low-calcium, low-vitamin-D diet continuously through prenatal and postnatal life, the latter for 120 days; and again combining an adhesive non-nutrient substance (gum-tragacanth powder), excess of sugar, and freely soluble alkali (sodium carbonate) to stimulate production of mucous saliva. These experiments were accompanied by controls so arranged that the effect of each factor could be determined individually. A thorough microscopic examination of sections of the jaws and bones of all these animals (nearly 200) has revealed interesting changes, but nothing comparable to true dental caries was obtained. Lesions of the dentin at the tips of abraded cusps occurred in a few animals similar to the lesions reported recently by Klein and Shelling; but it was not felt that these lesions were truly comparable to enamel caries in young human beings. A photomicrograph by Barker (*Journal of the American Dental Association*, 1931, xviii, p. 28; Jan.) indicated that dental caries may occur in the enamel pits and fissures of rat teeth. A paper by Shibata (*Japanese Journal of Experimental Medicine*, 1929, vii, p. 247) outlined conditions for producing it, which, although very uncertain in their implications regarding causation, provided means for the reproduction of this important finding. Rats, placed at weaning on a

diet of unground brown rice plus 8 percent of dextrin, and 5 grams of spinach per day, were killed in sub-groups at intervals and sections prepared from their jaws. All of these rats after five weeks or more showed evidence of a destructive process in molar teeth that appeared to be identical with human dental caries of the most prevalent type. *Drs. Rosebury* and *Karshan* are conducting further experiments involving modifications of these conditions. The fact that dental caries can be produced at will in rats opens the way to correlated bacteriological, chemical, and nutritional studies under conditions of control impossible with human subjects.

Other investigations in the Department of Bacteriology, completed by *Dr. Richard Thompson* (*Proceedings of the Society for Experimental Biology and Medicine*, 1931, xxix, pp. 103, 106), include a confirmation of the work of McIntosh, *et al.*, Rodriguez, and Bunting, *et al.*, on the incidence of aciduric bacilli in carious mouths, and their frequent absence from non-carious mouths, and a study of the relationship of blood groups to caries susceptibility, as a clue to the possible action of an hereditary factor. No difference was found in the distribution of blood types between individuals having caries and others free from caries.

Dr. Blackberg of the Department of Pharmacology is engaged with *Dr. Cahn* in a series of animal experiments on dietetic deficiencies running through several generations. Lesions like dental caries have been induced in dogs and rats by dietary deficiencies that interfere with normal Ca and P metabolism. Their recent findings have been striking. These lesions are associated with pulpal changes in a way to suggest that the latter are precursors of the enamel decalcification. A paper on this subject has recently been published by *Drs. Blackberg* and *Berke* (*Journal of Dental Research:* 1932, p. 349; April).

Much of the histological work is devoted to testing the hypothesis that susceptibility or non-susceptibility to dental caries is due to factors within the tooth, especially to the constitution of fluids diffusing through the enamel from the dentin and pulp. *Dr. Bödecker* believes "that dental decay will finally be proved to be primarily a disease of the dental pulp, and that the health of this organ will be shown to be dependent on the health of the individual." Related experiments aim to determine the nature of the fluids in the enamel; to demonstrate

channels in the enamel through which fluid may diffuse; to demonstrate the mechanism of circulation of fluids in the dentin; and to show the effects of impaired circulation in, and of diseased conditions of, the pulp. To this end *Dr. Applebaum*, by means of the Klein electro-endosmotic-apparatus, has forced a solution of mercuric chloride into the enamel from the pulp chamber, to demonstrate the channels by which fluids may diffuse into the enamel. His work indicates that fluid, under experimental conditions, diffuses with extreme slowness and only under considerable pressure; and only in young teeth extracted before the enamel pores have become occluded with calcic material. These findings (*Journal of Dental Research*, 1931, xi, p. 611; Aug.), indicate that fluid movement in the enamel normally must be very slight unless high pressure exists to force it. Some recent work by Klein (*Journal of Dental Research*, 1932, xii, p. 87; Feb.) suggests that membrane potentials may be developed in enamel sufficient to cause movement of liquid through that tissue. A recent report by Karlström (Monograph: A.-B. Fahlcrantz's Boktryckeri, Stockholm, 1931) indicates that lime salts are added to and subtracted from the inner layer of enamel in accordance with physiological conditions of the body. These findings strengthen the idea that diffusion of fluid in the enamel occurs in an amount sufficient to affect the structure of that tissue. Whether such fluid plays an important part in causing susceptibility or non-susceptibility to the dental-caries process, on or in the enamel surface, remains to be determined.

Dr. Bödecker has prepared histological material that further demonstrates the existence of Newman's sheath in the dentin. This structure, he believes, has the function of returning the fluid forced into the dentin by the odontoblastic cells through the dentinal fibrils. By proving its existence, he adds support to the theory that the dentin normally has a definite circulation of fluid. *Dr. Bödecker* has attempted to reduce the blood supply to the pulps of teeth in a rabbit by surgically eliminating the nerve supply and most of the blood supply to one side of the jaw. The animal has survived the operation and is apparently functioning normally. It will be a matter of great interest to see the effects of a prolonged reduction in blood supply on the structures of the involved teeth. The experiment will be repeated on monkeys offered for the purpose by the Department of Neuro-

pathology. *Dr. Cahn* is testing the hypothesis that dental caries is secondary to changes in the pulp. Studies of the pathology of dental caries have shown a zone of increased calcification just ahead of the decalcified areas in vital teeth. The zone is detected by taking x-ray photographs of sections of carious teeth. Papers on these histologic findings have been published (*Dental Cosmos*, 1930, p. 1001; Oct., and 1931, p. 995; Oct.). Besides the histopathology of the tooth tissues, *Dr. Bödecker* has made further progress with his caries index. By means of this method, it is much easier to make a statistical analysis of dental examinations. Data on this subject have been published (*Dental Cosmos*, 1931, p. 707; July; and *Dental Survey*, 1931, vii, p. 23; Dec.).

An outstanding achievement is the result of *Dr. McBeath's* work on child feeding in orphanages, in confirmation of the findings of Boyd and Drain (*Journal of the Amer. Medical Assn.*, 1928, xc, p. 1867; June 9). In carefully controlled experiments over an 8-month period, he has succeeded in greatly reducing the incidence of caries in three groups of children, totalling 82. In one institution, where the incidence of caries was already low, the number of new cavities was reduced to two-thirds of that of the control groups; in two other institutions, to less than one-sixth that of the control groups. These results justify the belief that dental caries is a manifestation of nutritional deficiency capable of control by regulation of the diet. Experiments conducted to learn the beneficial effects of vitamin C added to the regular diet, through different fruit combinations, have not so far shown specific benefit with regard to caries susceptibility. The experiments have not run long enough, however, to disprove definitely the assertions of Hanke and others regarding the resistance-producing effects of orange juice in large quantities. An experiment designed to determine the efficacy of large additions of vitamin D alone was inconclusive because of the rapid turn-over of children in the institution selected. This has been resumed with a more stable group of children. *Dr. McBeath* has not observed "arrested decay" in the children discussed above. He has found it, however, in patients in the Children's Clinic of the Dental School, both where pulpal function had practically ceased, as in deciduous teeth with roots greatly absorbed, and in pulpless teeth. This finding seems to indi-

cate that the hardening and darkening of decalcified dentin, and the cessation of the carious process implied in the term "arrested decay," are related to local conditions of the pulp rather than to general nutritional factors. A paper by *Dr. McBeath*, on this human nutritional study, will be published in a succeeding issue of this *Journal*. (See abstract, p. 538.) An interesting incidental finding in the work in orphanages is the unsolicited observation by the orphanage personnel that the group of children on the Boyd-and-Drain diet had far fewer colds and sicknesses than any of the other groups. This year, with the experimental group and control group reversed, the experimental group is again having the least sickness. In the nutritional studies *Prof. Eddy* coöperated not only by putting at our disposal the jaws of a great number of rats killed after various types of dietary experimentation in his laboratory, but also by analyzing the diets used in the orphanages in terms of units of vitamins as well as of other food factors.

52. THE GENERAL PRACTITIONER AS A RESEARCH WORKER: WITH A CONSIDERATION OF THE RÔLE AND RESPONSIBILITY OF THE DENTAL SCHOOL IN THIS CONNECTION

James L. Zemsky, D.D.S., Department of Oral Surgery, Midtown Hospital, New York City

It has been definitely established that clinical research as well as laboratory research is essential for the most satisfactory progress of dental science and art. To make clinical research effective, the general practitioner must take an active part. The participation of the general practitioner in clinical research was recommended by Claude Bernard as far back as the middle of the 19th century. Various attempts to stimulate activity in this direction have since been made by other writers, but in vain. Failure has been due to the existence of circumstances that are not conducive to success, and unless these are removed, success is impossible. To effect such a change there must be established an organization that would stimulate the practitioner to proceed with scientific investigation, guide him in his efforts, and correlate his findings with those of other workers. In order that the practitioner may be qualified to conduct research, he

must be prepared for it by the school in which he is trained for his profession. Great care must be taken so to perfect his training that interest in, and love for, research will be developed, rather than a dislike, as is the case in other relationships, in the dental curriculum in some schools.

53. DENTAL GRADUATE-STUDY AND RESEARCH IN CANADA AND THE UNITED STATES

William J. Gies, Ph.D., Sc.D., LL.D., F.A.C.D., F.A.A.P., School of Medicine, Columbia University, New York City

For *oral* presentation, the author selected data regarding only a few medical and dental schools in the United States. The conditions at Rochester, New York, appear to be more favorable for graduate study and research, and for intellectual and scientific leadership, in dentistry, than in any other *medical* school in North America. The following facts were quoted from an approved formal statement:

"At Rochester there are now eight Rockefeller Fellows in Dentistry—B. G. Bibby, B.D.S., W. McL. Davis, D.D.S., C. D. M. Day, B.D.S., E. C. Dobbs, D.D.S., H. C. Hodge, Ph.D., H. T. Knighton, D.D.S., H. J. Sedwick, D.D.S., and Grant Van Huysen, D.D.S. [Five participated in the program of this meeting, pp. 454 and 551.] The Dental Fellows are entirely free to conduct studies of their own selection. They may register for the Ph.D. degree, and will receive it when the character and extent of their work meets the requirements established by the University for the award of that degree. Thus far none of the Fellows has matriculated for a supplementary degree. *The Fellows are not encouraged to become candidates for the M.D. degree. It is believed that men who conduct graduate work in dental relationships, on the plan at Rochester, will not only retain their interest in dentistry,* but also develop a greater capacity in dental practice or a cumulative ability in dental science, and become unusually effective as teachers and investigators, especially in schools of dentistry." The Dean of this Medical School has recently expressed the following opinion, which is particularly significant in this connection: "I think it unlikely that physicians, unless they have a particular interest in the border subjects between medicine and dentistry, will maintain a permanent

interest in dental research. This interest may be fostered for a period of special grants, but after these grants are used up or the individual matures, he will probably revert to medicine and not be a permanent investment for dentistry. . . . . The nucleus of . . . . [the] research group [for the advancement of dentistry] in my opinion must be dentists who have had the dental training and have a permanent interest in this field, who have taken the time to get additional training in some of the pre-clinical sciences. This of course corresponds to the make-up of the pre-clinical science group in medicine today. I feel a strong conviction, therefore, that individuals who would help dentistry should first help to develop research workers with dental training and dental interest."

At the Yale Medical School—again quoting from approved formal statements—there are now four Dental Fellows—S. S. Arnim, D.D.S., H. A. Miller, D.D.S., David Weisberger, D.M.D., and J. J. Wolfe, D.D.S. Men holding these fellowships [Rockefeller] are "given opportunity *to get the training offered by the medical curriculum, then to serve on the hospital staff as internes, assistant residents and residents in clinical medicine.*" They "supplement their previous training in the pre-clinical subjects, then take an examination to test their qualifications for clinical work—during this period they are engaged in some investigative work and spend some time in the Dental Clinic to keep up with clinical dentistry. *It is hoped that in this way there may be developed a group of men who will be equipped to give a clinical service hitherto undeveloped; namely, the treatment of dental disease as a part of clinical medicine*; and also that some of those who get the training offered by this program may return to schools of dentistry as instructors, and carry with them a new point of view to influence their students."

There have been occasional intimations, from several dentists who are seeking to *force* a degrading change in the status of dentistry, that Cornell and Tulane Universities, which do not have dental schools, are developing plans, in their medical schools, intended, *regardless of the judgment of the dental profession*, to make dentistry a specialty of medical practice. The respective deans, in their replies to the author's inquiries, did not indicate that any such plans are in progress. Typical of the completely negative attitude of many *medical* schools is the

following view, as expressed at the Harvard Medical School: "This medical school does not give any formal course in dentistry to the students of medicine. The school, likewise, does not offer any similar opportunity for graduate work in medicine by dentists. Rarely we have admitted men with dental degrees for degrees in medicine. *Normally, unless the man with a dental degree desiring to study medicine has a clear-cut reason for wanting the additional preparation given by a course in medicine, the school does not consider such an application favorably.*"

The scope and importance of graduate study and research in *dental* schools are steadily increasing, as the programs of the successive meetings of this Association abundantly testify. After alluding to the preceding reports by Drs. Bunting (p. 467) and Leonard (p. 473), as suggestive of the important conditions at Michigan—where graduate opportunity in dentistry was first offered, in 1894—and at Columbia, the author indicated that of the remaining dental schools in the United States the three in Chicago are showing the greatest activity and progress in graduate work and research, and cited data regarding number of graduate students, activity in research, publications of research, etc. (To be published in the *Journal of Dental Research.*)

IX. Papers Read by Title: Abstracts 54–111[23]

A. Contributions by Members of the Vienna Section; Abstracts 54–73

54. STATISTICS ON DENTAL CARIES

Fritz Driak, M.D., Dental Institute (Director Prof. Dr. H. Pichler), University of Vienna, Vienna, Austria

An examination of 22,672 teeth in 1,100 patients showed that the frequency of caries (in Vienna) is 71 percent. Of the teeth examined, 12.19 percent were carious. Sex had no influence. Good care of the teeth diminishes the development of tartar. As for the relation of incidence of caries to age, and the caries-frequency of the different teeth, there was a fair agreement with the records of previous observers. General diseases like rickets and tuberculosis predispose to

[23] Of these papers, all are represented by abstracts excepting 59 and 61. A paper on the official program, by Dr. S. J. Major, was withdrawn and not read by title.

caries; diabetes, arthritis, and nervous disorders seem to have little influence. Caries occurs infrequently in cases of hereditary lues and of carcinoma.

55. EFFECTS OF DIATHERMY IN EXPERIMENTAL ROOT-CANAL WORK

B. Gottlieb, M.D., and B. Orban, M.D., Histological Laboratory (Director Dr. B. Gottlieb), Dental Institute (Director Prof. Dr. H. Pichler), University of Vienna, Vienna, Austria

The teeth of several dogs, after extraction of the pulps, were treated by surgical diathermy, which has been variously recommended to

FIG. 4. TOOTH TREATED BY DIATHERMY

a—Calcified fibers of periodontal membrane. *b*—Alveolar bone. *c*—Dentin. *d*—Cementum.

disinfect the tissues of teeth, and to promote circulation by hyperemia in the inflamed tissues around the apices. Our experiments, however, did not result in the expected success. In most cases, where the current was above 65 ma. and acted longer than 5 seconds, there was a typical fusion between cementum and alveolar bone. The fibers of the periodontal membrane were calcified and ossified. *Fig. 4* shows an area of a tooth treated by diathermy. The fibers of the periodontal membrane are calcified (*a*), the change progressing in the direction of the fibers, the fusion gradually becoming more extensive, complete

ankylosis resulting (*fig. 5*). In some cases, there was calcification of the fibers and fusion of the tooth without any resorption of the surface of the root. In others, resorption of the cementum first took place, followed by ankylosis. No favorable result was obtained in any case from the use of diathermy in root-canal work. The dithermic current seems to damage the cells of the periodontal membrane, which leads to ankylosis.

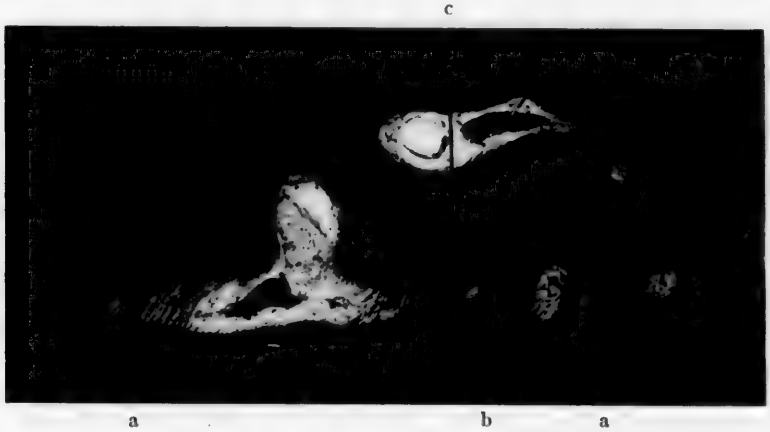


FIG. 5. TOOTH TREATED BY DIATHERMY

a—Calcified fibers of periodontal membrane. Complete ankylosis of tooth (*b*) and bone (*c*).

56. HISTOPATHOLOGIC BASIS FOR THE IMPRESSION TECHNIQUE FOR FULL DENTURES

Richard Grohs, M.D., Histological Laboratory (Director Dr. B. Gottlieb), Dental Institute (Director Prof. Dr. H. Pichler), University of Vienna, Vienna, Austria

When one wants to place a full denture on a toothless jaw, the substitute set of teeth is expected to transmit the masticatory power of the jaw. Engineers understand the importance of carefully studying the foundations upon which they build. Dentists must do the same. From a thorough knowledge of the conditions of the jaw tissues, they can properly adapt dentures. Histological examination

shows that, in laying the foundation of a denture, one must select the parts seemingly predestined for it; namely, the alveolar processes in the upper and lower jaw. This is the place where the prosthesis is supposed to be based and to be firmly attached. The sections of the palatal mucous membrane, excepting the raphe, assist in increasing adhesion by close apposition of the denture, although in the first place they have to balance the pressure. There the substantial submucous parts of the mucous membrane act to a certain degree as buffers. The sections of the raphe palatina, because it has only a thin lining of mucous membrane, must be protected against over-pressure. This may be done by leaving a depression under the denture. Near the zygomatic process the denture should not fit too closely.

An occasional depression must be left at places where, on palpation, the patient feels pain due to the pressure. The pressure on the foramina palatina majora should not be reduced, the vessels and nerves in this region being sufficiently protected by nature from over-pressure. Following the appendage of the muscles, the margin of the denture should be closely adapted. The border of the upper denture toward the pharynx should be close behind the margin of the hard palate, where there are regions of thick mucous membrane with plenty of fatty and glandular tissue. The back border of the denture must be closely fitted at this line. The maxillary fundaments, including the marginal areas, can be moulded very suitably with plaster-of-paris impression, combined with shellac plates, as modified by us for this purpose (*Zeitschrift für Stomatologie*, 1931, xxix, p. 673.)

57. EXTENSIVE OSTEOMYELITIS AFTER TOOTH-EXTRACTION

Otto Hofer, M.D., Jaw Department (Director Prof. Dr. H. Pichler), First Surgical Clinic (Director Prof. Dr. A. Eiselsberg), University of Vienna, Vienna, Austria

In a patient 33 years old, the right mandibular third-molar was painful in mastication (May 1929), but there were no signs of inflammation in the soft tissues nor evidence of trismus. When extraction was attempted, the tooth was fractured. In a few days, pain was felt, but it gradually diminished. Mastication occasionally caused pain. Early in December, 1929, the pain grew worse, when the patient came to our Oral Surgery Department. An x-ray film showed the existence of a large granuloma near the mandibular canal.

Extraction of the remaining portion of the fractured tooth was performed easily under conduction anesthesia. Next day the pain continued, attended by fever, swelling of the cheek, and anesthesia in the lower jaw. When a fluctuation in the vestibulum oris was discovered, three days afterwards, an incision was made from $\overline{8}|$ to $\overline{5}|$, an abundant flow of pus resulting. The temperature continued to rise; the anesthesia extended to the other cheek. A coarse, wood-like infiltration beneath and behind the lower jaw was found, and in the region of the right mandibular nerve there was complete anesthesia. The flow of pus from the incision was abundant. Meanwhile the treatment was conservative—hot air and rinsing the mouth. Gradually the infiltration extended to the left side, where all teeth were loosened and sensitive to pressure as far as the region of $|\overline{5}$, a great amount of pus flowing away. A considerable incision was made in the whole vestibulum oris, extending to the left side and the environs of $|\overline{5}$. The periosteum in the region of the molars on the right side was already dead. No perforation of pus through the bone could be detected. The next day the swelling continued to increase, and the teeth were looser. On the left side, in the region of the mentalis muscle, there was considerable hyperesthesia. When the tampons were removed next day, pus flowed from the right foramen mentale. Five holes were then bored (under a narcotic) into the corpus mandibulae, both in front and behind the foramen mentale, where much pus was flowing. Next day, swallowing having given much trouble, an outside incision was made 6 cm. above the clavicula, opening into a big abscess situated high up inside the ascending ramus. This incision and that in the vestibulare the day before were joined. Three further incisions had to be made—partly from the inside, partly from the outside—to remove pus from the soft parts of the mouth.

A month later (Jan. 9, 1929), when the patient was finally free from danger, x-ray films showed almost entire dissolution of the lower jaw. All the loose teeth were bound by ligatures (formed like the figure eight) and held together by an improvised stirrup of wire. Later, x-ray films showed further marked destruction; then the slow regeneration of the whole lower jaw. The loose teeth were joined, by the improvised dressings, with india-rubber bands to the upper teeth. We succeeded, despite the softness of the jaw bone, in adjusting the occlusion and in preventing a deviation of the individual fragments

of the jaw. The patient has been under our treatment for two years. The last x-ray film showed complete healing of the osteomyelitic process on the left side and in the region of the right ascending ramus. In the region of the premolare there is a wide pseudoarthrosis. In the tooth-bearing middle, there is a sequestrum whereby several teeth as well as sequestra of bone will be lost. We are patiently watching the case, without interfering with its progress. The following are the notable features:

(1) Since the osteomyelitis followed immediately after extraction of the tooth, the process had presumably been chronic and localized, but was immediately made acute by the extraction. (2) It is very likely that the extension took its course along the mandibular canal. This opinion is confirmed by the first x-ray film. (3) Probably it would have been better not to leave the fractured third-molar tooth in the jaw for months, since the granuloma doubtless expanded meanwhile and extended dangerously near the mandibular canal. (4) The acute osteomyelitis was an extensive, life-threatening disease. During the acute state it required very active treatment (incisions into soft parts of the mouth, trepanations of bone). (5) The loose teeth were not extracted. The teeth lost by the patient fell out, or were thrown off with sequestra. The remaining loose teeth were carefully held in place, thus preventing dislocation of the jaw fragments in spite of spontaneous fracture.

This serious disease was initiated by an extraction conducted by an experienced practitioner under aseptic precautions. The outcome shows the necessity for the utmost care in conditions of this kind, especially with reference to oral cleanliness and the administration of the anesthetic.

58. PERSISTENT BLEEDING OF THE UPPER JAW STOPPED BY BLOOD TRANSFUSION AND LIGATION OF THE EXTERNAL CAROTID

Otto Hofer, M.D., Jaw Department (Director Prof. Dr. H. Pichler), First Surgical Clinic (Director Prof. Dr. A. Eiselsberg), University of Vienna, Vienna, Austria

A man, 75 years of age, knocked down by a motor car, was taken into the Accident Department of Prof. Eiselsberg's Clinic. He had a

wound (bruise and cut) 10 cm. in length on his left forehead; an extensive hematoma on both sides of the border of the eyebrow. There was bleeding from the nose—later, serous exudation—also fracture in the region of the left maxillary cuspid accompanied by profuse bleeding. The patient remained in the Accident Department 13 days; then, despite his general ill-health, but at his own wish, was dismissed. At home he was very weak, and remained in bed; twice he vomited large amounts of blood. A physician found him "bleeding from the lungs," and directed him to the Internal Clinic, where it was seen that the bleeding came from the mouth and he was transferred to the Oral Surgery Department. Here a bluish tumor, the size of a dove-egg, was found on the left maxillary tuberosity extending to the mucous membrane of the cheek. It had an aperture the size of a dime, an irregular border, and was clogged by blood coagula. During the night violent bleeding from the nose and mouth set in, continuing for some time. Finally it was stopped by an energetic tamponade. In the morning of the same day, in agreement with Prof. Eiselsberg, a blood-transfusion was made (ca. 55 cc. of blood). Ligation of the vein seemed to be excluded—the patient had a severe collapse before and after the transfusion—so it was not advisable to make another transfusion. The appearance of the tumor suggested a metastasis from a hypernephroma. The patient's health having improved 24 hours after the transfusion, the external carotid artery was then ligated just below the branching off of the lingual artery. The original tampon in the region of the tumor of the upper jaw was left in place. Next day, when changing tampons, extensive necrosis was noted in the tumor; the outer portion of this necrotic mass had no tumor tissue. Urological examination revealed a relative insufficiency of the left kidney, and serious functional disturbance of the right. Skeletal examination showed a strong shading and condensation of three lumbar vertebræ, and we seemed to be dealing also with an osteoplastic metastasis. The x-ray film of the maxillary region showed destruction of the bones, especially of the zygomatic process. The patient was then transferred to the Internal Clinic; and a fortnight later, feeling relatively well, was dismissed, when the following report was made: "Hypernephroma of the right kidney and metastases in the third lumbar vertebra, and in the left maxillary tuberosity. As an operation is not

indicated, the patient is left to domestic care." The patient withdrew from further medical control and care, and it was difficult to persuade him to call again at the Clinic. He felt completely well. In the oral cavity, the process macroscopically is externally healed; only a minute fistula remains, situated between the alveolar border and the muco-buccal fold, without appearing, when probed, to have entered the tumor substance. The x-ray film shows a shading of the third lumbar vertebra, although its contour remained almost the same. The kidneys did not trouble the patient.

The diagnosis is difficult. It is very likely that an existing hypernephroma, made necrotic by energetic tamponade and by ligature of the carotid, disappeared spontaneously. It is very remarkable that the patient has no trouble either with his kidneys or the lumbar vertebræ. It is possible that, as a result of the accident, he had a fracture of the upper jaw, and, because of the highly sclerotic condition of the arteries, unusually severe bleeding followed, causing the hematoma and filling the space between the fractured parts with granulation tissue. The latter, abundantly supplied with veins, was made necrotic by the ligation of the carotid. The conditions in the kidney and in the lumbar vertebræ arose as a consequence. Possibly the change in the third lumbar vertebra was caused by the trauma, and the damage to the kidney was not associated with the tumor. The patient, who after the accident was in a deplorable condition, and with whom the transfusion of blood had been a last resort, was actually saved by this procedure, and by the accompanying ligation of the carotid. He has been restored to health, which is remarkable considering his age.

59. SCURVY-LIKE EFFECTS OF A SODIUM-CARBONATE DIET ON THE JAWS OF DOGS

Ernst Kellner, M.D., Histological Laboratory (Director Dr. B. Gottlieb), Dental Institute (Director Prof. Dr. H. Pichler), University of Vienna, Vienna, Austria

No abstract received for publication.

60. TWENTY-SIX CASES OF ADAMANTINOMA UNDER SURGICAL AND RADIUM TREATMENTS COMBINED

Emerich Kotanyi, M.D., Jaw Department (Director Prof. Dr. H. Pichler), First Surgical Clinic (Director Prof. Dr. A. Eiselsberg), University of Vienna, Vienna, Austria

Pichler, in his work on "conservative treatment of adamantinoma," described a conservative method of operation, and cases successfully treated thereby. The method follows: In a case of multilocular cysts, the cover and partition-walls of the individual cysts are removed. If the cystic membrane is as thin as that of the usual cyst, it is not removed. In this way, one large cystic cavity is created, which communicates with the mouth. If some parts of the cystic membrane are thick and tumor-like, they are removed. If such tumor-like thickenings occur in several parts, the whole swelling must be completely removed, and the bone scraped. After the operation, radium treatment is applied. Pichler justified his conservative method by this comment on the *radical* procedure: "The resection of the mandible, where most adamantinomata are found, is a heavy mutilating operation. In spite of excellent results in immediate prosthesis and in bone plastics of the lower jaw, it is a terrible necessity to have to use an operation like this." The use of Pichler's method is determined by the localization and extension of the tumor. When situated high in the ascending ramus of the mandible, resection is necessary. But resection is not necessary even with very large tumors, when they are situated in the ramus horizontalis of the mandible, or in the chin-region.

In the literature there are descriptions of 200 cases. Of these 10 (5 percent) were malignant; 1 (3.84 percent) of our 26 was malignant. Adamantinomata are 8.89 percent of the *benign* tumors of the jaw (236 such cases in our Department) and 3.11 percent of *all* tumors of the jaw (674 such cases in our Department). Of our 26 cases, 14 were in women; 12, in men. In recent years, we were able to control eight operated cases, 5 of which did not relapse, 3 did. Of the 5 that did not relapse, *Case 7*, during $8\frac{1}{4}$ years, was treated with 200 mg. of radium. *Case 8*, during $5\frac{1}{2}$ years, was treated with 1940 mg. of radium. *Case 20*, during 1 year, was treated with 960 mg. of radium. *Case 24*,

during 2 years, was treated with 1410 mg. of radium. *Case 26:* under observation a year; no radium treatment; no relapse. These data show that we applied for cases that did not relapse, from 200 to 2000 mg. of radium. Two relapsing cases were treated with 1128 mg. and 725 mg. of radium, respectively. Only 4 of the 26 cases were resected. We hope that these data, soon to be extended, will save many patients having adamantinoma from the consequences of hasty resection of the jaw.

61. UEBER EINEN BEHAARTEN POLYPEN (EPIGNATHUS)

H. Mathis, M.D., University of Vienna, Vienna, Austria

No abstract received for publication.

62. NEW VIEW-POINTS ON THE QUESTION OF EPITHELIAL ATTACHMENT AND GINGIVAL CREVICE

B. Orban, M.D., Histological Laboratory (Director Dr. B. Gottlieb), Dental Institute (Director Prof. Dr. H. Pichler), University of Vienna, Vienna, Austria

Examination of a large amount of human material leads to the conclusion that the structure at the epithelial attachment depends on functional and mechanical influences on the gum margin. The epithelial attachment is the portion of the gum epithelium that is attached to the surface of the tooth. This tissue is fixed to the tooth, and follows all its movements. The gum margin is limited on one side by the epithelium of the mucous membrane of the oral cavity, and on the other side (toward the tooth) by the epithelium of the gingival crevice, the bottom of which is at the point where the pocket epithelium joins the epithelial attachment; that is to say, where the epithelium is attached to the tooth surface. The gum margin is exposed to different insults from the outside. While the epithelial attachment is fixed to the surface of the tooth, and follows all its movements, the gum margin is free and exposed to mechanical influences of various kinds. This difference in the functions of the epithelial attachment and gum margin results in a difference in the structure of each. The gum margin of an incisor of a person 35 years old is shown in *fig. 6*, where we see the different structures of the free

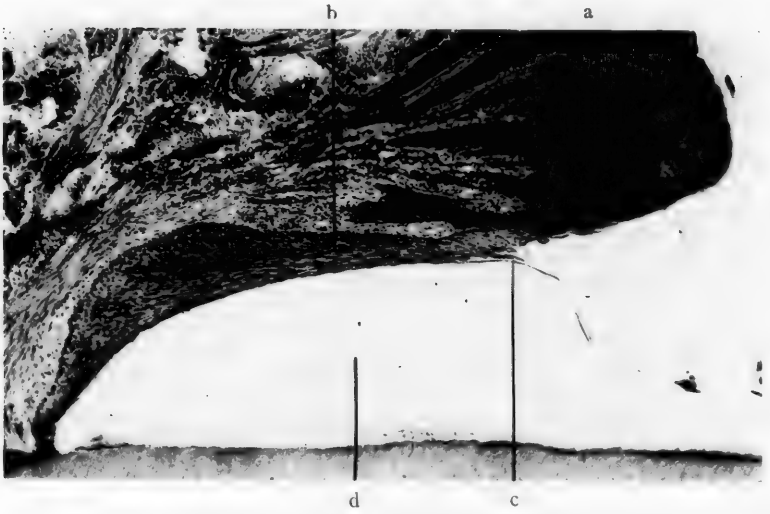


FIG. 6. PALATINAL SIDE OF $\underline{1}^{|}$; FROM PERSON 35 YEARS OLD

a—Free gum-margin. *b*—Fixed epithelial-attachment. *c*—Bottom of gingival crevice. *d*—Enamel (lost by decalcification of specimen).

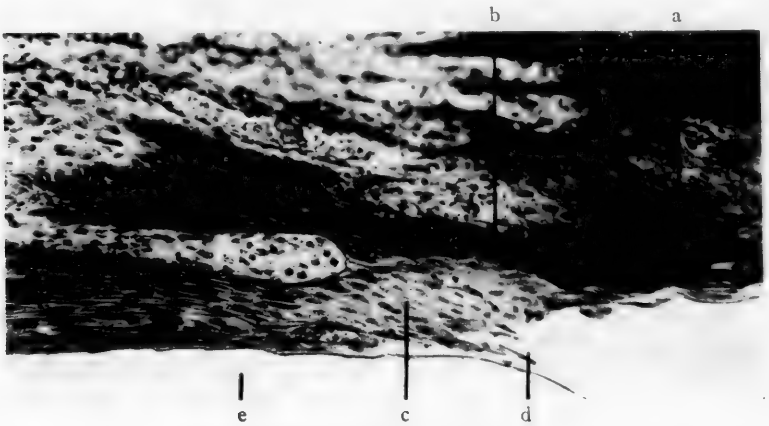


FIG. 7. HIGHER MAGNIFICATION OF *fig. 6*

a—Hornified surface of pocket epithelium. *b*—Flattened elongated-cells on border line of gum epithelium and epithelial attachment, *c*. *d*—Bottom of crevice. *e*—Enamel.

gum-margin (*a*) and the fixed epithelial attachment (*b*). At the border of the gum margin and epithelial attachment (*fig. 7*), the cells of the former are darkly stained and elongated; those of the attachment are more roundly shaped and lightly stained. This difference in

FIG. 8. HIGHER MAGNIFICATION OF *fig. 7*

a—Gum epithelium. *b*—Elongated cells on border of gum epithelium and epithelial attachment, *c*. *d*—Bottom of crevice formed by degeneration of innermost layer of cells of epithelial attachment. *e*—Enamel cuticle.

structure is due to the different functional influences to which these tissues are exposed. The formation of the pocket progresses by degeneration of the cells attached to the surface of the tooth, and by separation of the epithelium therefrom (*fig. 8*).

The cells in the epithelial attachment show a certain structural arrangement, which is due, I think, to functional influences on this tissue. If we observe a specimen as shown in *fig. 9*, we see that the

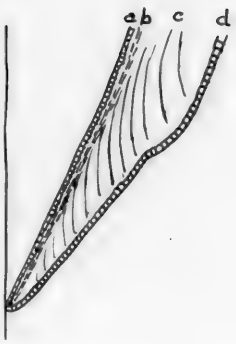


FIG. 9 FIG. 10

FIG. 9. EPITHELIAL ATTACHMENT OF $\underline{2}$; FROM PERSON 19 YEARS OLD
Notice shape and direction of cells in attachment. See diagram, *fig. 10*

FIG. 10. DIAGRAM ILLUSTRATING SHAPE AND DIRECTION OF CELLS IN EPITHELIAL ATTACHMENT SHOWN IN *fig. 9*

cells nearest the surface of the tooth—that is, those attached to the tooth—are cuboid in shape (*fig. 10, a*). The cells next to these are elongated (*fig. 10, b*) in shape, and run parallel to the surface of the tooth. The cells following these (*fig. 10, c*), toward the connective

tissue, are obliquely inclined. The cells of the outermost layer (*fig. 10, d*), cuboidal in shape, are the basal cells of the epithelial attachment. This arrangement of the cells of the epithelial attachment is also shown in a high magnification of a human specimen (*fig. 11*). The cause of this structural arrangement of the cells in the epithelial attachment is due, I think, to functional influences. One side of the

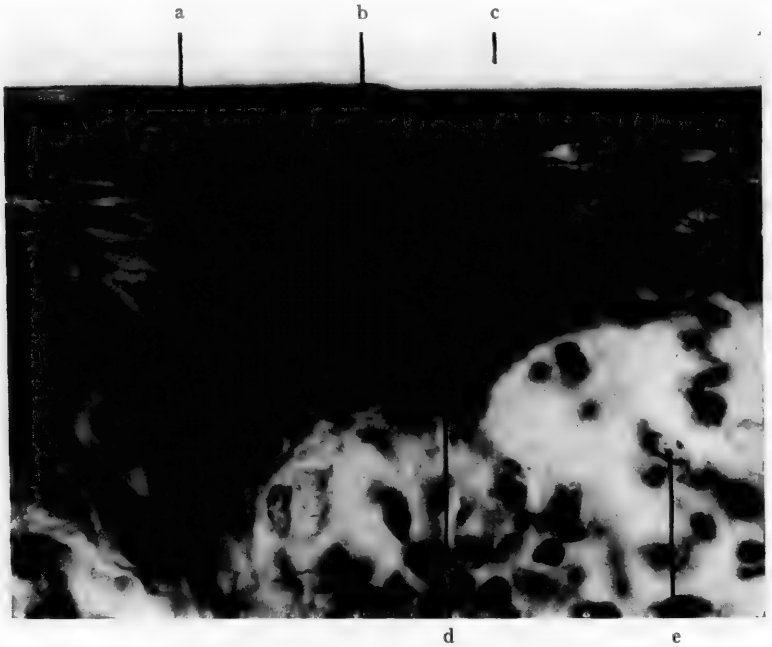


FIG. 11. EPITHELIAL ATTACHMENT OF HUMAN TOOTH

Notice functional arrangement of cells in epithelial attachment, *a*. *b*—Cuticle. *c*—Enamel. *d*—Outermost layer of attachment, basal-cell layer. *e*—Connective tissue.

epithelial attachment is fixed to the surface of the tooth and follows all the movements of the tooth. The other side of the attachment is in fixed connection with the connective tissue. Owing to the connection of the epithelial attachment on both sides, to tissues of different function, the structure of this attachment is expressed in the different shape and direction of its cells.

63. TUMORS OF THE JAW AND THEIR EARLY DIAGNOSIS: A POSTGRADUATE LECTURE

Hans Pichler, M.D., Dental Institute, University of Vienna, Vienna, Austria

The best treatment for tumors of the jaw is early operation; treatment with radium or x-rays, alone, is not reliable, for in the long run more harm than good may result because it may postpone operation and cause loss of precious time. The diagnosis of such tumors, of different ulcers of the mucous membrane, and of pre-cancerous conditions, is considered (in the lecture). The dentist or physician who as a rule has the first chance to see a tumor, can do more than anyone else to save the patient's life by early diagnosis. An important early symptom is the loosening of a tooth without apparent cause. Such a tooth in a suspicious case should not be indifferently extracted, but a microscopic examination should be made or the patient with the tooth in situ referred to an experienced specialist. Advances in the treatment of malignant tumors of the jaw enable the practitioner, more effectively than before, to avoid the deformities following operation by resorting immediately to prosthesis and bone-grafting. But this applies only rarely to non-malignant tumors, especially adamantinomata and "brown tumors," which may be handled with sufficient safety by minor operation and radium or x-ray treatment.

64. REPORT ON THE SURGICAL TREATMENT OF MALIGNANT TUMORS OF THE UPPER JAW[24]

Hans Pichler, M.D., Jaw Department (Director Prof. Dr. H. Pichler), First Surgical Clinic (Director Prof. Dr. A. Eiselsberg), University of Vienna, Vienna, Austria

Of 182 cases, 125 were male, 57 female; average age, 52.9 years. In 157 cases, the microscopic diagnosis was carcinoma; in 25, sarcoma. Among the latter (15 males, 10 females) no so-called giant-cell sarcomata were included, because we consider that these belong to a benignant inflammatory type. Statistics that include these "brown

[24] Abstract of a paper read at the 55th Surgical Congress, in Berlin, 1931, April 10: *Arch. für klinische Chirurgie*, 1931, clxvii, p. 769.

tumors" show a larger number of sarcomata and better results of treatment. Among these 182 patients, only 32 (17.6 percent) refused operation or were considered inoperable. The rest were treated by resection of the upper jaw; 25 of them, operated in other hospitals, were examined and watched by me, because an immediate (14) or postoperative (11) prosthesis was constructed for them in the laboratory of my Clinic; but they are not included in the statistics of my results, which refer accordingly to a total of 157 (133 carcinomata, 24 sarcomata), including 32 inoperable cases. Thus 125 cases (109 carcinoma, 16 sarcoma) have been operated in my Clinic, most of them by myself. The large number of operations compared with the number of cases examined (82.4 percent) shows that we have tried to pronounce the sentence "inoperable," which is a death-sentence in most cases, as infrequently as possible despite the fact that most patients have consulted us pretty late (an average of 4.6 months after the first symptoms of the disease, excluding cases of longer standing than one year—all very-slowly-growing basal-cell cancers). Often the operation had to be extended farther than the borders of the upper jaw; we removed the pterygoid process in 25 cases, the eye or the whole content of the orbit in 20, part of the mandible in 14, and parts of the skin with the jaw in 18. Of the cases treated by resection, 30 were cancers that recurred after a first operation in another hospital.

Immediate and permanent prosthesis for cases of resection of the upper jaw has been so well developed, in Vienna, that it is possible with a simple technique to restore the function of speech and mastication, and to avoid diplopia and disfigurement in practically all cases. My rubber prosthesis is hollow, light in weight, and can easily be removed and replaced by the patient. It is voluminous, filling the whole cavity and keeping it extended for free inspection, a feature of great value for the early diagnosis of local recurrences. Immediate skin-grafting of the inside of the cavity has been practised in 46 cases, with very gratifying results. If the glands are enlarged and growing, it is my practice to remove them at a second operation. Statistical data are given in *table 5*. Others give 35.9 percent (*Holmgren*) or 36 percent (*New*) of what they call permanent cures. But in some cases this permanence involved a period of observation lasting not longer than 15 months (*New*), or 5 months (*Holmgren*) after operation!

TABLE 5

*Data on the results of surgical treatment of malignant tumors of the upper jaw**

	Number of resections	Death in consequence of operation within 1-2 months	Death after 2 mos.	Recurrence when patient was seen last time	Patients free from recurrence when last examined	Free from recurrence after a period (at least)							
						From 0.5 to 12 months	From 1 to 2 years	From 2 to 3 years	From 3 to 4 years	From 4 to 5 years	From 5 to 10 years	From 10 to 15 years	From 15 to 16 years
		percent	percent	percent	percent	percent	percent	percent	percent	percent	percent	percent	percent
	125	14—11.2 (8.9)	45—36; average after 11.3 months	12—9.6 (7.5); average after 16 months	54—43.2; average after 29.3 months	30—24	27—21.6	25—20	21—16.8 (13.3)	18—14.4 (11.5)	13—10.4 (8.3)	5—4	1—0.8
Patients treated with radium or x-rays after operation	74	3—4.1	35—47.3; average after 11.8 months	8—10.8; average after 19.9 months	28—37.8; average after 42.8 months	16—21.6	15—20.2	14—18.9	14—18.9	11—14.9	9—12.2	3—4.1	
Patients not treated with rays after operation	51	11—21.6	10—19.6; average after 9.7 months	4—7.8; average after 9.5 months	26—51; average after 14.8 months	14—27.5	12—23.5	11—21.6	8—15.7	7—13.6	4—7.9	2—3.9	
Sarcomata	16	2—12.5 (8)	4—25; average after 13.3 months	1—6.3 (4); average after 6 months	9—56.3; average after 48.8 months	3—18.7	6—37.5	5—31.3	5—31.3 (20.8)	5—31.3	3—18.7 (12.5)	1—6.3	
Sarcomata; postoperative ray-treatment	8	0	2—25; average after 13.3 months	1—12.5; average after 6 months	5—62.5; average after 47.9 months	1—12.5	4—50	3—37.5	3—37.5	3—37.5	2—25	.....	
Sarcomata without postoperative ray-treatment	8	2—25	2—25	0	4—50; average after 49.9 months	2—25	2—25	2—25	2—25	2—25.5	1—12.5	1—12.5	

* Percentages in parenthesis refer (according to Holmgren's suggestion) to the total number of cases—157 (133 carcinomata and 24 sarcomata).

65. A METHOD TO REMOVE CAST CROWNS

Otto Preisecker, M.D., Histological Laboratory (Director Dr. B. Gottlieb), Dental Institute (Director Prof. Dr. H. Pichler), University of Vienna, Vienna, Austria

By the old methods it is very difficult to remove a cast crown from a tooth in the mouth, because the sidewalls consist of hard cast gold. I have devised a new method. With a wheel-shaped stone, an opening is made on the buccal or lingual side of the crown, between the tooth and the innerside of the morsal surface of the crown, by cutting into the latter. With a fine drill, this cleft is extended toward the opposite

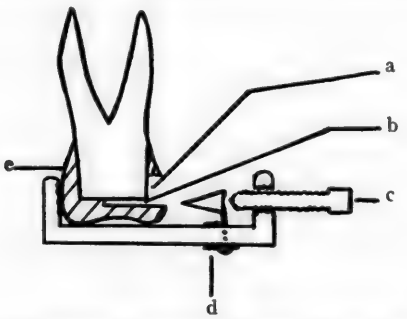


FIG. 12. DIAGRAM OF TOOTH AND MECHANISM SHOWING METHOD FOR REMOVAL OF CAST CROWN

a—Opening in crown. *b*—Cleft. *c*—Screw. *d*—Wedge to be pushed by screw. *e*—Cast crown.

side. Into the crevice, is screwed a wedge as shown in *fig. 12*, where my device is illustrated. By this method it is very easy to remove a crown without affecting the tooth, and without pain. It is impossible to apply this method to a tooth that is extensively decayed, or which has an elastic filling (guttapercha).

66. THE EFFICIENCY OF CHEMICAL MEANS FOR THE DESTRUCTION OF ANEROBIC BACTERIA[25]

K. Rieger, M.D., and R. Trauner, M.D., University of Vienna, Vienna, Austria

The effect of H_2O_2, formaldehyd, chloramin, pantosept, tincture of iodine, alcohol, sagrotan (a derivative of phenol), rivanol and iodine

[25] Rieger and Trauner: *Arch. f. klin. Chir.*, 1930, clx, p. 40.

solution (Albrecht), on two anerobic spore-producers (B. phlegmon. emphys., and B. putrificus) and an anerobic streptococcus, have been determined. Only the H_2O_2 seemed to have a specific effect, all other agents acting alike on the anerobic and aerobic microbes. Sagrotan, alcohol and rivanol did not kill the spore-producers, 4 percent chloramin solution killed in 30 minutes; 3 percent H_2O_2 in 4 hours; 6 percent formaldehyd, in one day. All killed the anerobic streptococcus in a few minutes except rivanol and formaldehyd, the latter doing so in 30 minutes. The effect of tincture of iodine was very uncertain, but always more destructive with 70 to 48 percent alcohol than with 96 percent. In dentistry anerobic conditions often occur in the treatment of root canals. From this point of view, and from several others, we prefer the chloramin solution to tricresolformalin for temporary inlays, tricresol having no effect on spore producers. Besides, tricresol and formalin unite chemically, the disinfective effect of the compound being small and slow, to say nothing of the irritating effect of tricresol.

67. THE LOCALIZATION OF RED MARROW IN THE JAWS, AND ITS SIGNIFICANCE IN PATHOLOGIC PROCESSES

Franz Schönbauer, M.D., Histological Laboratory (Director Dr. B. Gottlieb), Dental Institute (Director Dr. H. Pichler), University of Vienna, Vienna, Austria

Histological examination of human jaws has demonstrated that, in childhood, red marrow is distributed equally in both jaws. With increasing age the red marrow disappears, successively from the front to the end of each jaw, being displaced by fatty marrow. In adults red marrow occurs in the ascending ramus of the lower jaw and in the angle of the jaw. The extensive circulation in red marrow permits bacteria and cells of tumors more easily to lodge in these areas than in parts of the jaw having fatty marrow, where the vessels are rare and the circulation is slight. To illustrate: a man at 47 died of urosepsis originating in cancer of the prostate and compression myelitis. Histologic investigation of the jaw showed a tumor in the region of the lower margin of the mandible, where red marrow regularly occurs. This tumor originated from that in the prostate. The many wide vessels in the red marrow permitted cells of the tumor to lodge in the

jaw. In the same way, metastatic osteomyelitis may develop by deposition, in the red marrow, of bacteria circulating in the blood from an infective lesion.

68. THE FOUR DEGREES OF BIOLOGIC EFFECT CAUSED BY ORTHODONTIC FORCES

A. Martin Schwarz, M.D., Histological Laboratory (Director Dr. B. Gottlieb), Dental Institute (Director Prof. Dr. H. Pichler), University of Vienna, Vienna, Austria

In experimental investigations with orthodontic spring-forces of determined intensity, the author showed[26] that biologically the most favorable treatment is that which works with *forces not greater than the pressure in the blood-capillaries*. This pressure in men and most mammalia is 15–20 mm. Hg—about 20–26 grams per sq. cm. of surface. With this knowledge, we are able to divide as follows, the biologic effects produced by orthodontic forces:

First degree of biologic effect. This force is so short in duration, or so slight, that no reaction is induced in the periodontium.

Second degree of biologic effect. The force is "tender," remaining below the pressure in the blood-capillaries, i.e., less than 20–26 grams per sq. cm. of surface. But it is sufficiently intensive to induce continuously a more or less lively resorption on the alveolar-bone in the regions of pressure. Biological events after removal of this force: anatomic and functional restitutio ad integrum of the periodontium and the alveolar-bone; no resorption of the root.

Third degree of biologic effect. The force is "middle-strong," being just sufficient to overcome the pressure in the blood-capillaries of the regions affected. At these areas, bloodlessness of the tissues, suffocation of the strangled periodontium, and resorption of the necrotic tissue-parts beginning in the areas of pressure, occur. This resorption, taking an impetuous course, attacks the surface of the root at the areas where vitality may be injured by the pressure. Biological event after removal of the force: functional restitutio ad integrum of the

[26] Schwarz: Tissue-changes during orthodontic tooth-movement effected by fine auxiliary springs: Second Int. Orthodont. Congr., London, July, 1931.

periodontium, the alveolar bone, and the resorbed surface of the root; possibly, also, progressive resorption of the dentin.

Fourth degree of biologic effect. The force is "strong," mechanically squeezing the strangled periodontium on the side of pressure. At its maximum degree, the tooth touches the bone after the soft tissues have been crushed. Resorption occurs around the regions of pressure, but resorption from the marrow-spaces is undermined. There is danger that the injured tooth-surfaces may be resorbed. Biological event after removal of the force: the same as for the third degree; also danger of pulp-death resulting from tear in the tissues, crushing or bleeding at the apex, and ankylosis of the tooth with the alveolar-bone.

The foregoing data show that, in practice, *continuous forces of more than 15–20 grams per sq. cm. of surface* cannot be used without exceeding the limits of the biological optimum. Teeth react very differently to the same orthodontic force. The cause of these individual differences is the *constitutionally different speed of bone-resorption.* The above classification demands of modern orthodontic appliances that the used forces *must be objectively measurable.* This is not commonly the case with Angle's appliances, its screws and ligatures. On the contrary, Mershon-Lourie appliances meet this requirement. To the numerous advantages of the latter, the objective measurability of the spring-forces is added. Further, the forces of elastic rubber-rings are measurable. Forces resulting from the swelling of silk, wood, or rubber-wedges are not measurable, and usually are too strong from the biological point of view.

69. SEXUAL DIMORPHISM OF THE UPPER LIP

Harry Sicher, M.D., First Anatomical Institute (Director Prof. Dr. Tandler), University of Vienna, Vienna, Austria

In laughing and speaking a portion of the upper teeth becomes visible. In every textbook on prosthesis it is said that the extent of this exposure—area of teeth and often the neighboring part of the gums—is due to the length of the upper lip. Exact observations show that normally, in *women*, the upper lip is shortened and pulled upward by the contraction of the respective muscles much more than in men.

Complete exposure of the crowns, and of a part of the gum, is therefore characteristic of the laughing of women, and is only exceptionally seen in men. The male beard is the cause of this difference, the heavy hairs rendering the cutis thick and rigid, and preventing folding as in women. This female attribute, like so many others, is infantile. It is clear that knowledge of this condition is of the greatest importance in prosthetics.

70. DO ANY ADAMANTINOMATA BECOME MALIGNANT?

Karl L. Spring, M.D., Jaw Department (Director Prof. Dr. H. Pichler), First Surgical Clinic (Director Prof. Dr. A. Eiselsberg), University of Vienna, Vienna, Austria

Among the tumors of the jaw, adamantinomata occupy a separate position. Although they may be wholly benignant, as shown by extended clinical experiences, they possess certain characteristics of the malignant type. In numerous cases they have a special propensity for local and regional relapses, many surgeons on this account resorting to radical operative treatment (a large resection of the jaw). This propensity for local and regional relapse is explained by the infiltrative growth of an adamantinoma. In most cases, adamantinomata also grow expansively, thus differing from malignant epitheliomata. The main difference between a carcinoma and an adamantinoma lies in the fact that an adamantinoma may grow in bone to the greatest extension, but seldom enters soft parts. *A carcinoma develops in bone and soft parts, growing in all directions and into all tissues.* Clinically we never observed malignancy in our rich material of adamantinomata. Cases showing such behavior are very rare. In the literature I have found only one case of adamantinoma[27] that not only infiltrated the bones but extended into the soft parts autodestructively. In distinction from the malignant epithelial tumors, regional metastasis in the lymphatic glands has never been observed in adamantinomata. The occurrence of haematogenous metastasis has not yet been demonstrated.

The following interesting case has been under observation in our

[27] L'Esperance: A preliminary report of adamantinoma. *Proceedings of the New York Pathological Society*, 1910, x, p. 136.

Department. The patient, 16 years old, has had a swelling in the lower jaw since his fifth year, for which seven operations were performed before his 15th year, in different clinics, the swellings always recurring. On his admission to our Department, he showed on the left side of the chin a tumor limited to the jaw bone. From clinical and roentgenological evidence, it seemed to be an adamantinoma (multicellular cystoma). Histological examination of the tumor, after operation, showed the typical picture of a partly solid, partly cystic, degenerated adamantinoma. One month later several tubercules the size of a hazelnut appeared in the frontal bones. One of these tubercules was removed by operation. Histologically it had the qualities of an epithelial tumor, which in structure simulated a cystic degenerated adamantinoma. Here was an instance of an epithelial tumor of the lower jaw, regarded as an adamantinoma and which, in histological and clinical features, showed the criteria of an adamantinoma, and led to the formation of metastasis in bones of the head.

Summary. Usually adamantinomata are clinically benignant. They tend toward local relapses, which are caused by rests of tumors not radically removed by operation. Sporadic cases may behave like carcinomata, leading either to the formation of haematogenous metastases or of adamantinomata limited to the bones of the jaw, and so changed that the cells of the tumor push on infiltratively. When the tissue of an adamantinoma degenerates to sarcoma, there results an unrestricted growth extending to the soft parts and involving metastasis. (Published in the *Zeitschrift für Stomatologie*, 1932, xxx, pp. 455 and 608).

71. EXPERIMENTAL PRODUCTION OF GRANULOMATA AND EXPERIMENTAL ROOT-CANAL TREATMENT

Georg Stein, M.D., Histological Laboratory (Director B. Gottlieb), Dental Institute (Director Prof. Dr. H. Pichler), University of Vienna, Vienna, Austria

Clinical and x-ray criteria alone are not sufficient to provide conclusive scientific evidence of the success of root-canal treatment. For this reason experimental root-canal treatment has lately been acquiring

cumulative importance. In most animal experiments heretofore devitalised teeth, with intact periodontal tissue, were used, and the treatment was comparable with that of devitalised human teeth. But the results indicated little regarding effects of treatment of teeth having periapical foci. Anatomical conditions at the apices of dog teeth are particularly suitable for a study of principles affecting the treatment of periapical infection in human teeth, because there is no proper foramen apicale, the pulp dividing into numerous narrow canals, and thus presenting difficulties analogous to those attending delivery, in human teeth, of therapeutic agents to all the infected ramifications. Since 1927 I have conducted investigations in the following way: The pulp chambers of a large number of teeth in narcotised dogs were opened, and either left open or, as in most cases, the pulps were destroyed and infected with streptococcus cultures from apical foci, and the teeth then filled. After periods of different length there developed periapical foci which histologically were like those at the roots of human teeth, although the presence of epithelium was perhaps less frequent. The periapical foci thus produced were x-rayed, and different methods of treatment were applied in order to ascertain how the existing foci reacted. Premolars and molars were used by preference. By treating one root of a bicuspid while the other remained untreated, the influence of the procedure could be directly determined. X-ray films were made at successive stages of the treatment.

In one series of treatments, the foci were considerably diminished, but only rarely eradicated. In six months to a year, after the beginning of an experiment, the dogs were killed and the periapical tissue examined histologically. In most cases the inflammatory processes were more or less extended, but in some there was a close approach to healing. When the foramen apicale was perforated during the treatment, and excess of filling material passed into the periapical tissue, good healing resulted, including the formation of cicatrix-like tissue poor in cells. Often the excess was separated from the root apex, and a cicatrix-like tissue poor in cells was formed between the root apex and the detached excess of filling. In one case an osseous layer was formed between root apex and detached excess of filling, and a new root-apex alveolus was produced. X-ray examination

showed that the filling excesses were often diminished after treatment. Migratory cells stuffed with filling material were often found throughout the sphere of treatment. Diathermy in many cases caused fusion between root and bone, as found by Gottlieb and Orban (see abstract, p. 484).

The present preliminary experiments have not progressed far enough to demonstrate the advantages of any particular method. For this reason, the nature of the treatments has not been indicated.

72. A CASE OF HEALED DIFFUSE-ATROPHIC BONE-RESORPTION DUE TO CHANGE OF DIET

Josef Weinmann, M.D., Histological Laboratory (Director Dr. B. Gottlieb), Dental Institute (Director Prof. Dr. H. Pichler), University of Vienna, Vienna, Austria

Cases of diffuse atrophy of the jaw that have been favorably influenced by internal treatment, and in which the course of healing has been controlled by x-rays, are very rare. Therefore, the following case seems to be of some interest. The patient (32 years old) of athletic type (sportsman) was feeling perfectly healthy. He consulted me regarding the loosening of some teeth. The $\overline{1}|$ had fallen out a few days before the first consultation. The $|\underline{2}$ had been almost completely exfoliated, and was exceedingly loose; $|\overline{1}$ and $|\overline{2}$ were very loose. The palatinal root of $|\underline{6}$ had already completely exfoliated; other teeth had also become more or less loose. There was very little tartar; no inflammation. X-raying of the teeth gave no findings, excepting for $|\overline{1}$ and $|\overline{2}$ (*fig. 13*), each of which had a large radiolucent area around the apex, showing resorption. The epithelial attachment was lying somewhat apically from the cemento-enamel junction. The teeth showed no decay, had no filling, and to electric tests were vital. The internal examination, which we generally undertake in such cases, was postponed for a long time because of the patient's occupation. The blood examination for sugar was negative. The cholesterol, calcium, and bilirubin in the blood, which were not determined until nine months later, also remained within normal limits. Determinations of oxygen metabolism were not made. The patient had been in the habit of eating chiefly meat and pastries; fruit and vegetables were

neglected. After the first consultation, the patient greatly reduced the meat in his diet. He now eats plenty of vegetables, and nearly two pounds of fresh fruit a day. The first x-ray photo (*fig. 13*) was taken on December 16, 1930; the control photo (*fig. 14*), on September 12, 1931. The latter shows healing of the large radiolucent areas around the apices, which means that bone formation took place in this area. This change in the structure of the bone around the apices is surely due to the change from a mainly-protein diet to a mixed diet containing vegetables and fruits, Although every case of diffuse atrophy

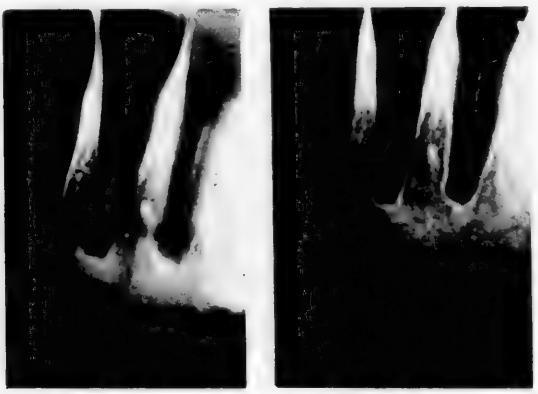


FIG. 13 FIG. 14

FIG. 13. ROENTGENOGRAM OF TEETH, DEC. 16, 1930, SHOWING LARGE RADIOLUCENT APICAL-AREAS

FIG. 14. ROENTGENOGRAM OF TEETH, SEPT. 12, 1931, SHOWING APICAL HEALING AND BONE FORMATION

may be different in its etiology from other cases, and we must investigate every case individually and treat it according to the findings, the present case shows one of the possibilities in the treatment of disturbances of the jaw by internal measures.

73. THE NEW COURSE OF INSTRUCTION AT THE DENTAL SCHOOL OF THE UNIVERSITY OF VIENNA

H. Wolf, M.D., Docent, Dental School (Director: Dr. H. Pichler), University of Vienna, Vienna, Austria

The new regulations for the instruction of dentists were inaugurated in Austria two years ago. Dentistry in Austria has always been

considered a part of medicine, and originally only physicians were entitled to practise dentistry. However, there was no legal requirement for a special training, just as there has been, and is, none in other medical specialties. But since dental technicians have increasingly abused their rights in the practice of dentistry, this condition has been terminated by the passage of a law granting certain rights to the dental technicians during a period of transition, but preventing further increase of practitioners who are not physicians. At the same time the use of the title "Zahnarzt," dental physician, was made subject to the completion of a prescribed course and the passing of an examination. This gave a final legal foundation in Austria to the conception that dentistry shall be practised only by full physicians.

The curriculum for natives now extends through four semesters and can be completed only by doctors of general medicine, although attendance by foreign physicians and by advanced students of dentistry from foreign universities is permitted. The directors of the School recommend that the course be begun in a winter semester, because there is not sufficient time in the short summer-semester for three important courses of *preliminary* instruction (*table 6*, lectures 6, 9, 12). However, students of medicine who expect to take the dental courses and to acquire the title of "Zahnarzt," doctor of dentistry, in addition to that of "Arzt," doctor of medicine, are given opportunity, in extra work, to acquire manual skill at the very beginning of their studies and to cover the courses of the first semester of the dental curriculum, thus enabling them, after graduation in medicine, to complete the dental requirements in three semesters and then to take the examination in dentistry. This privilege has the following foundation in the legal regulations: Those doctors of medicine who can readily attest that they successfully prepared themselves *in the field of dental technic through three semesters* during their course of medical studies may be absolved from one of the four semesters of the course in dentistry prescribed for the training of dentists. This legal requirement is fulfilled if they attend thrice the practical course of "dental technical laboratory work for medical students" at the School. But, to enable the doctors of medicine, when continuing their studies in dentistry, to start at once the work on patients at the Dental School, medical students are advised to take all the work of the first semester of dental instruction during the course of their medical studies.

In most cases medical students can give up one semester of their medical course for this purpose and accomplish this work in the Dental School on a coördinated program. The medical student has the right to spread the study of the first dental semester over the period of his medical studies, but uninterrupted attendance at one dental semester is preferable. On this plan, a graduated medical student may begin

TABLE 6

Required lectures of the 4-semester dental course (curriculum)

NO.	TITLES OF LECTURES (COURSES)	NO. OF HOURS PER WEEK	REQUIRED IN THE INDIVIDUAL SEMESTER[1]			
			I	II	III	IV
1	Semester-lecture course on dentistry, with practical work for medical students	3	Y[1]	—	—	—
2	Applied anatomy for dentists	1	Y	Y	—	—
3	Biology of the teeth	1	Y	Y	—	—
4	Radiology	1	Y	Y	—	—
5	Operative dentistry	5	Y	Y	—	—
6	Preliminary course in operative dentistry, with practical exercises	10	Y	—	—	—
7	Practical instruction in operative dentistry	15	—	Y	Y	Y
8	Prosthetics	5	Y	Y	—	—
9	Preliminary course in dental technic, with practical exercises	13	Y	—	—	—
10	Dental technical laboratory work for medical students	6	*	—	—	—
11	Practical instruction in prosthesis	20	—	—	Y	Y
12	Preliminary course in exodontia	5	Y	—	—	—
13	Lecture course in exodontia with practical exercises	2	Y	Y	—	—
14	Lecture course in orthodontia for beginners	1	—	—	Y	Y
15	Orthodontic exercises for beginners	3	—	—	Y	Y
16	Oral and jaw surgery, with presentation of patients	2	—	—	Y	Y
17	Exercises in jaw surgery	3	—	—	Y	Y

[1] In columns I, II, III, IV, the letter Y signifies that the corresponding required registered course is given in the semester indicated.

* For medical students, as indicated in the text.

the practical dental work on patients at the opening of the second semester. Thus, the students who seek the degree of doctor of dentistry (all of whom have already acquired the degree of doctor of medicine) work for three semesters in the infirmaries on patients. Since this mode of instruction produces intervals between the first

and second dental semesters, minor theoretic practical examinations in operative dentistry and prosthetics (colloquia), immediately before admission to the work on patients, are prescribed. In *table 6* all required lectures of the 4-semester course are summarized in a definite curriculum. The schedule of the 4-semester course is given in *table 7*.

The instruction in operative dentistry follows essentially the

TABLE 7

Daily schedule of the 4-semester dental course (curriculum)[1]

DAYS	8–9	9–10	10–11	11–12	12–1	1–2	2–3	3–4	4–5
Monday.....	5 | 5	8 | 8	9 | 7	6 | 7	6 | 7		9 | 7	9 | 7	12 | 7
	7	7	7	11	11		11	11	11
Tuesday.....	5 | 5	8 | 8	9 | 7	6 | 7	6 | 7		9 | 7	9 | 7	12 | 7
	16	7	7	11	11		11	11	11
Wednesday.....	5 | 5	8 | 8	13 | 13	13 | 13	9 | —		9 | 7	9 | 7	12 | 7
	7	7	7	11	11		11	11	11
Thursday.....	5 | 5	8 | 8	6 | 7	6 | 7	6 | 7		9 | 7	9 | 7	12 | 7
	7	7	7	11	11		15	14	—
Friday.....	5 | 5	8 | 8	6 | 7	6 | 7	6 | 7		9 | 7	9 | 7	12 | 7
	7	7	7	11	16		11	11	11
Saturday.....	1 | —	1 | —	1 | —	4 | 4	2 | 2	3 | 3	— | —	— | —	— | —
	17	17	17	—	15	15	—	—	—

[1] The figures specify the lectures (courses) indicated in *table 6*. Explanation of square and rectangular arrangement:

1 Sem. (Winter) | 2 Sem. (Summer)
3 and 4 Semesters

teachings of Black; in prosthetics, those of Gysi. The instruction in orthodontia, and oral and jaw surgery, begins in the third semester and is continued until the end of the course (*table 6*, lectures 14–17). Further specialization in these two subjects within the limits of the curriculum, however, cannot be obtained. In order to give the students in exodontia additional opportunity for practice during the second year, they are assigned in turns to the ambulatory service of

the School, beginning in the third semester. The required instruction in jaw surgery is given weekly in five hours (lectures 16 and 17), one hour of which is devoted to systematic lectures, one hour to demonstrations on patients, and the remaining three hours to practical exercises on the cadaver or on patients. The instruction covers the entire pathology of the jaw, with special consideration of the diseases that start from the dental system. The treatment of fractures of the jaw and congenital clefts can also be discussed and demonstrated in detail, since the Jaw Department mentioned below presents an abundance of material of this kind. Students who wish to train themselves for specialization in orthodontia or jaw surgery are given the opportunity to do so by attendance at optional lectures and exercises. In jaw surgery, in particular, extensive opportunity of this kind for specialization is available at the Jaw Department of the First Surgical Clinic, which, open throughout the year, functions also as the surgical division of the Dental School. Because of lack of time, however, such attendance by dental students is not permissible at any other times than during the Christmas, Easter, and summer vacations. The school hours of the Dental School are 8–1 and 2–5 on Monday to Friday and 8–2 on Saturday.

The instruction of the future Austrian dentists, on the basis of the recommended plan of studies, will comprise 9 semesters of medicine proper, 2 semesters of dental technical laboratory work, and 4 semesters of purely dental work. We hope that the professional training of our future colleagues will be commensurate with the pains taken.

B. Contributions by Other Members of the Association, and by Guests, Who Could Not Be Present: Abstracts 74–111

74. INCIPIENT DENTAL CARIES

Edmund Applebaum, D.D.S., Dental School, Columbia University, New York City

The changes seen in incipient caries of the enamel were studied by polarized light. The author's results partly confirm the work of Andresen, who claimed that carious enamel may be remineralized by saliva. X-rays in the author's study of the carious region showed, however, that the enamel at the spot assumed to be remineralized

by saliva was still decalcified. This finding is inconsistent with the concept of remineralization. A resistance to the acid by the enamel is suggested by a dense band (polarized light) of demarcation between the decalcified enamel and the normal enamel. The saliva may assist in protecting enamel, but not to the extent of entirely remineralizing a decalcified "white spot." (To be published in the *Journal of Dental Research.*)

75. SODIUM PERBORATE: PHYSICAL, CHEMICAL, AND BACTERICIDAL PROPERTIES

Henry A. Bartels, B.S., D.D.S., Department of Oral Pathology, School of Dental and Oral Surgery, Columbia University, and Benedict Gordon, B.S., F.A.I.C., New York City

The authors reviewed the literature on the physical, chemical, and bactericidal properties of sodium perborate, and its applications in medicine and dentistry. Experimentally sodium perborate was found to be only slightly affected by exposure to air. Light has no effect upon its stability when stored in stoppered glass-bottles. The concentration of sodium perborate in aqueous solution is dependent upon the temperature of the water. Aqueous solutions undergo decomposition on standing. Sodium perborate—a heaping teaspoonful to a glass of water at 45°C.—decreases the bacterial flora of fresh saliva 50 percent after an exposure for from 3 to 5 minutes; in the presence of blood, it loses its bactericidal potency. Streptococcus fecalis was more resistant to its action than either the staphylococci or hemolytic streptococci in the mouth. (To be published in the *Journal of Dental Research.*)

76. SOME ABNORMALITIES IN THE HEAD AND NECK OF AN ANENCEPHALIC MONSTER

David D. Bloom, D.M.D., Dental School, Harvard University, Boston, Mass.

This work describes the dissection of an anencephalic monster (superior spina bifida). Conception occurred during the onset of the menopause. The face is characteristically anthropoid, with large bulging eyes and absence of a forehead. Some of the muscle fibers

indicate a reversion to primitive muscle arrangement. A long upper-lip contributes another factor indicating a reversion of type. The head is thrown back sharply, and dorsally there is bifurcation of the spine. As our nervous system represents the most highly specialized tissue, it follows that it would be the first to suffer in any abnormal development. (To be published in the *Journal of Dental Research.*)

77. COMPARISONS OF TEETH AND JAWS OF INDIANS OF THE SOUTHWEST WITH THOSE OF WHITE AMERICANS, ANCIENT NORDIC, LA NAULETTE, MAUER (HEIDELBERG) JAW, AND MALE CHIMPANZEE

Kent Kane Cross, D.D.S., B.A., University of Denver, Denver, Colo.

Among the close similarities of modern man and primitive peoples, wherever dispersed, and even in the higher apes, are the teeth and jaws. Abrasion of the teeth, diseases of the periodontal tissues, and dental caries, are traced to Neolithic man. The chin was markedly retruded or absent in fossil man and fossil anthropoid apes, although massiveness of the jaws and teeth, as well as well developed third molars, are characteristic of both groups. The ancient Crô-magnon conforms more nearly to the modern human jaw. On account of the wide distribution of the Amerinds, climatically and geographically—from the Arctic coast to Terra del Fuego—problems of food, clothing, and shelter caused great physical variances among the aboriginal Americans. Those discussed in this paper are the Pueblo-Cliff dwellers of southwestern United States. The paper deals primarily with measurements, although the shovel-shaped incisor and the rough and faulty enamel mentioned by Dr. C. F. Bödecker, are noticed. Teeth and jaws were examined in three museums in Colorado. Each group shows practically the same characteristics and conditions. Loss of many teeth, and of one or both condyles, posthumously, is a common condition.

Differences in function is the principal cause of variances in size, form, and condition of teeth and jaws. The measurements of Indian teeth are slightly greater than those of modern white people, excepting that from gingival margin to incisal or occlusal surface, which on account of abrasion—not so much from coarse food (largely maize) as from grit from their grinding stones—is usually less. This abrasion

is excessive, even in the deciduous teeth of small children; it is greater in the molar region, but decreases again at the third molar. Here the occlusal plane is either worn flat, from right to left; or often in a decided reverse curve, instead of the usual direct curve approximating the sector of a sphere. Of the 383 teeth examined, only four in two jaws had been carious. A few instances of impacted third molars were found; in others, as is also true of the ancient Nordic, no external evidence of third molars exists. Only one jaw shows unmistakable evidence of periodontoclasia. The Nordic skulls and teeth show more evidence of refinement than those of the Indians. The chimpanzee, although having the same dental formula of 32 teeth, does not resemble the human in size or form of jaws or teeth. The jaw is long and rectangular. The Mauer jaw and teeth are the most massive of those that are admittedly human. (To be published in the *Journal of Dental Research.*)

78. THE EVOLUTION OF HUMAN TEETH

Kent Kane Cross, D.D.S., B.A., University of Denver, Denver, Colo.

A summary of views in general accord with those published by W. K. Gregory in his "Origin and Evolution of the Human Dentition."

79. EFFECTS OF VARIOUS DIETS ON THE TEETH AND BONES OF ALBINO RATS

Wm. G. Downs, Jr., D.D.S., M.A., Ph.D., and R. M. McKeown, B.A., M.D., Medical School, Yale University, New Haven, Conn.

These studies are divided into three groups. In the first were utilized many diets in which the Ca:P ratio and vitamin-D content varied greatly. In the second, the protein, fat, and carbohydrate contents were markedly altered, the salt and vitamin contents remaining fairly constant. In the third, the Ca:P ratio was sharply upset as contrasted with minor changes in the first group. In each case the rate of incisor-tooth growth, the histopathology of the teeth and surrounding tissues, and the healing-time of fractured fibulae were studied. It was concluded that if vitamin D be added to a low-P diet, the histological changes are more marked than where such addition is not made. Obversely, where the Ca content is low, the

addition of vitamin D apparently helps the tissues to overcome the changes noted. Marked Ca, P, or total-salt deficiencies resulted in decalcification of the teeth from the pulpal side outward, resulting in a condition simulating caries, but differing in its natural history. Similar changes were noted in the high-carbohydrate, low-protein diet groups. Throughout, the best results in tooth growth and structure as well as bone regeneration were obtained on a high-protein diet with ample salt content; next, on high-fat diets; and least or poorest on high-carbohydrate diets. (To be published in the *Journal of Dental Research*, where a portion has already appeared: 1932, xii, p. 363; April.)

80. FUNDAMENTALS OF AN APPROACH TO THE VITAMIN-C PROBLEM

Wm. G. Downs, Jr., D.D.S., M.A., Ph.D., Chicago, Ill.

In this study a wide variety of food products commonly used as sources of vitamin C were studied; also different scurvy-producing diets, and different methods of diagnosis of scurvy, compared. It was found that the Dalldorf diet, with slight modifications in salt content, is the most dependable in producing scurvy; the presence of hemorrhage and osteoid formations in dental pulp, the most dependable criterion of vitamin-C deficiency; and the Indiana canned tomato-juice, the most dependable curative agent.

81. COMPARATIVE LIABILITY OF SURFACES OF DECIDUOUS TEETH TO DECAY

H. Shirley Dwyer, D.D.S., Research Clinic, Dental School, New York University, New York City

A study of reports on the dental liability of school children, as obtained from various health agencies, shows a conspicuous lack of standardization in securing and recording the data. In this study the standardizations included these precautions: *Observers*—specially instructed hygienists under supervision of experienced dentists. *Examination*—with mouth mirror, No. 17 S. S. White explorer, good light, dryness secured by cotton rolls; made *after* a cleansing. *Records*—detailed, on examination cards; later transferred to master sheets as used in this Clinic. *Final tabulation*—should show over a thousand cases recorded.

82. CONTRIBUTION TO THE BIOLOGY OF THE PULP IN ENDOGENOUS METABOLIC DISTURBANCES

Guido Fischer, D.M.D., Ph.D., Dental Institute, University of Hamburg, Hamburg, Germany

In all the endogenous metabolic disturbances that arise from various constitutional and local conditions, the pulp is the seat of congestion edema with its sequelae: vacuoles, edema, cysts, broad layers of predentin, cell atrophy, fibrosis, and calcification. The pulp seems to be predisposed, from an early age, to become a congested organ; the slightest disturbances in the capillary circulation lead to injury of the odontoblasts, of predentin, and finally of the pulp. In such teeth, however, the pulp continues to maintain metabolism and usually remains sensitive to the last. Congested pulps in all intact teeth always have an alkaline reaction—pH 7.44—which is higher than that of any other tissue (connective tissue, pH 7.20; blood, pH 7.36). The dentin, with its abundance of calcium salts, is the great reservoir from which the pulp can remove calcium salts at any time. The various shifts in the acid supply and acid formation in the tooth determine the absorption of calcium salts. But the alkalinity of the congested pulp remains constant, since its supply of calcium salts is nearly inexhaustible. These vast reserves in the intact tooth protect the pulp from premature death; they also protect the remaining nerve supply of the tissue against irritations of all kinds. These conditions indicate the importance of an artificial alkalosis in the treatment of diseased root-canals. Since the congestion of the pulp sets in at an early age as a physiological metabolic process, and is maintained throughout life, we may look upon it as the best biological condition attained by the pulp, which is naturally at a disadvantage both topographically and anatomically. The greatest foe of the pulp is, and remains, an enforced alteration of its alkaline character into an acid one, which occurs in the presence of bacterial activity. The exogenous sources of infection by way of caries are therefore the factors most inimical to a pulp that functions to old age.

These biological investigations disclose valuable practical perspectives of equal importance for the solution of the two greatest problems of our science; namely, the treatment of carious processes and of paradentosis. (To be published in the *Journal of Dental Research.*)

83–84. DIET AS A FACTOR IN CONTROL OF GINGIVITIS; AND DIET AS A FACTOR IN CONTROL OF DENTAL CARIES: A REPORT ON NUTRITIONAL STUDIES AT MOOSEHEART, ILLINOIS[28]

Milton Theo. Hanke, Ph.D., Otho S. A. Sprague Memorial Institute, and Department of Pathology, University of Chicago, Chicago, Ill.

A survey of the literature, and a study of 400 private patients, indicate that most people are ingesting diets deficient in vitamins and, possibly, in other constituents. Diseases of the oral tissues, such as gingivitis, periodontitis, and dental caries, are most frequently found in people whose diets are markedly deficient in one respect or another. A deficiency in vitamin C appears to be most common. A deficiency in vitamin D is not uncommon. Usually, then, we are confronted with at least a dual deficiency. On the assumption that much of the dental pathology is, in some way, associated with nutritional deficiencies, we have, for three years, been advocating a very liberal diet that should contain all of the constituents that are essential for the development of healthy body tissue, as follows: Eight oz. of *orange juice* and the juice of one-half *lemon*, once or twice daily, depending upon the age and gingival condition of the patient—patients with acute ulcerative gingivitis receive a quart of orange juice and the juice of four lemons a day for ten days, or until the acute condition has subsided. Eight to 32 oz. of *milk*—children: 32 oz.; adults, usually not over 8 oz. One or 2 *eggs*—adolescent children and pregnant women receive 2 eggs. One quarter to one-half head of *lettuce*. One-half lb. of *fruit besides the citrus-fruit juice*. Four-fifths to 1 lb. of *vegetables*. *Meat* once a day.

On this dietary régime, gingivitis that is not associated with calculus disappears fairly rapidly (30 to 60 days) in most cases. Calculus must, of course, be removed in any case, if a complete recovery is to be obtained. Alveolar bone is *not* regenerated. A large proportion of the pyorrhea cases have become free from pus, and most of the loose teeth have become satisfactorily tight. This takes time; in some

[28] This program has been conducted in collaboration with the Chicago Dental Research Club, Marion S. Needels, Carl M. Marberg, Winston H. Tucker, Charles L. Ghent, John M. Williams, and Myrtle D. Bartholomew.

cases as long as two years. Teeth that are very loose, due to a loss of alveolar bone, do not become tight and can hardly be kept free from pus. A large number of the patients who had formerly been afflicted with rapid progressive decay have remained free from dental caries for from two to three years. Some patients have been quite refractory and in some the amount of caries has decreased, but the process has continued. Nutritional deficiency is probably not the only cause of dental caries, but appears to be an important factor. We have never observed a case in which a spontaneous recalcification of a carious lesion has occurred. Although we have numerous cases in which the cavities have not become larger, we have none in which the cavities have become smaller.

These conclusions are so important from the standpoint of dental health that we desired to test them in a study of a large group of children under controlled conditions. We sought, therefore, a group of children who are in excellent health; enjoy all the advantages of home surroundings; obtain abundance of outdoor exercise, and a generous amount of solar radiation; are happy, and not particularly subject to psychic disturbances; receive excellent dental and medical care; and whose food is at least equivalent to that of the average American child. We were fortunate, indeed, to obtain permission to conduct our study at Mooseheart, Illinois, because there the children enjoy all these advantages. The study was conducted upon 422 children ranging in age from 10 to 17 years; 323, observed for two years, were the "test" group; 99 observed for one year, were the "control" group. The 323 children in the test group were observed for one year while they were ingesting the standard Mooseheart diet. The diets were planned, and the dispensation of the foods supervised, by Miss Myrtle D. Bartholomew, dietitian at Mooseheart. The average daily food intake per child, calculated from accurate data covering the entire year period, is given in *table 8*. This diet, as good as or superior to that ingested by the average American child, is somewhat deficient in foods that contain vitamins A and D; also in vitamin C according to our standards. All but the small approximal cavities were filled at the beginning of this period by Dr. Charles L. Ghent or his assistant, Dr. John M. Williams, the resident dentists at Mooseheart. Gingival conditions were recorded by means of natural-color

photography. We also obtained fourteen-film dental roentgenograms of all children (at 12-month intervals); determined Ca (total and ultrafilterable) and total-P contents of the blood serum (at 6-month intervals); determined the pH of various regions in the mouth; obtained x-rays of the wrist (at 12-month intervals); made a study of the bacterial flora of the mouth; and determined the weight and height of the children at 6-month intervals. Of these children, 70.5 per cent had some form of gingivitis during this control period; 79.2 percent developed carious lesions. After one year on the standard

TABLE 8

Average daily food intake at Mooseheart, Illinois

FOOD	CONTROL PERIOD					TEST PERIOD				
	Quantity			Calories		Quantity			Calories	
	Girls	Boys		Girls	Boys	Girls	Boys		Girls	Boys
Milk	0.88	0.92	Quart	572	598	0.7	0.93	Quart	455	605
Bread	0.25	0.49	Pound	336	569	0.35	0.47	Pound	405	544
Butter	0.08	0.087	"	288	314	0.08	0.85	"	288	306
Sugar	0.103	0.112	"	192	208	0.11	0.105	"	205	195
Eggs	0.566	0.6	Egg	45	48	0.74	0.81	Egg	59	64
Fruit	0.46	0.47	Pound	194	208	0.54	0.41	Pound	176	159
Vegetables	0.845	1.05	"	227	282	0.626	0.93	"	163	252
Meat	0.212	0.246	"	295	350	0.216	0.243	"	303	339
Cereals	0.032	0.068	"	52	93	0.041	0.066	"	67	95
Sundries	0.206	0.227	"	341	394	0.194	0.22	"	319	371
Orange juice	.....	.....		.....	.....	1.0	1.0	Pint	200	200
Lemon juice	.....	.....		.....	.....	1.0	1.0	Lemon	40	40
Total				2545	3064				2680	3170

diet the cavities were again filled. No other dental work was done. The standard Mooseheart diet was then augmented by the addition of 16 oz. of orange juice and the juice of 1 lemon per day (this is the "test" period). Observations were continued during this "test" period. The exact average daily diet for this period is given in *table 8*. All the gingivitis that was not associated with calculus disappeared during the 1-year test period (citrus-fruit juice). Some of the cases with calculus were greatly improved; some became entirely healed in spite of the calculus. In most cases, however, the presence of calculus

effectively prevented improvement. Dental caries was arrested to the extent of 49.8 percent, and retarded to the extent of 16 4 percent. We consider caries to have been arrested if a child developed cavities during the 1-year "control period," but did not develop cavities during the 1-year "test" period. These results show that the carious process can be influenced by some constituent of orange and lemon juice in addition to the standard diet. This constituent may be vitamin C, but of course our work does not prove this. The diet was not as adequate as the one we have advocated to private patients; the results also were not so good. This fact may be very important.

The boys at Mooseheart, on the standard Mooseheart diet, showed a gain in weight and an increase in height that was below the normal standards for some of the age-groups. The addition of citrus-fruit juice to the diet led to an increase in weight and height such that the values, for this 1-year period, were often in *excess* of normal standards. Citrus-fruit juice, therefore, supplied something that materially enhanced rate of growth. This increase cannot be attributed to the slight increase in the number of calories ingested, because the standard diet at Mooseheart yields an adequate number. The results on the girls, in this respect, were not so striking; but the general trend was the same. The relation of total weight to height was approximately correct in all groups during either period. In the Ca and P determinations (blood serum), conducted at 6-month intervals on every child, (a) the values were all within the normal range; (b) the spring values were slightly lower than those for the fall, which may indicate a deficiency in vitamin D; (c) total and ultrafilterable Ca and total P were the same for the group that developed carious lesions and the group that did not develop carious lesions. The development of carious lesions is not associated with deviations in the Ca and P contents of the blood serum.

We have made a careful study of the occurrence of aciduric microorganisms (that are also acidogenic) in the mouths, because of the prevalent belief that the carious lesions in teeth are initiated by the decalcifying action of acids which, in turn, are produced by the metabolic action of bacteria on carbohydrates. Three groups of such microörganisms were demonstrated; namely, streptococci, almost always present; L. acidophilus, present as discussed below; and yeast,

present in about 33 percent of the mouths. L. acidophilus appeared consistently in the mouths of some children that were not afflicted with dental caries. This microörganism is not, therefore, an obligate producer of dental caries. This statement is equally true of streptococci. L. acidophilus was found most frequently and consistently (but not invariably) in mouths that contained numerous carious lesions. The accumulation of food debris in cavities may provide conditions favorable for the localization of this microörganism. Our bacteriological studies have neither proved nor disproved the theory that dental caries results from the action of bacterial products upon the tooth substance. Dental caries is most apt to occur in mouths of children who have had considerable caries in the past. Filling the old cavities does not, apparently, prevent the development of new cavities. A definite tendency toward dental caries exists, which appears to influence the progress of the disease during adolescence. We might consider this tendency to be due to heredity. This is a proper consideration, if we enlarge the definition of heredity to include a varied ability to remain healthy in the face of adversity. Since all the children at Mooseheart are living under identical conditions, the existing state of deficiency, dietary or otherwise, affects one child more unfavorably than another only if certain children compared with others require more of a given thing, or things, to remain healthy. It has long been claimed that the teeth decay most rapidly during the period of puberty. This is, indeed, the case; but the increase, during the period of puberty, is not very great. Improvement has occurred during the "test" period in *all groups* irrespective of previous tendency toward dental caries or the age of the child. Addition of citrus-fruit juice to the diet has in many cases overcome untoward effects of heredity and of puberty. This strongly suggests that citrus-fruit juice contains something with which these children were previously insufficiently supplied. The quantity of citrus-fruit juice administered was so large that it proved adequate for even the most deficient cases.

Conclusions. A group of apparently healthy children living under ideal conditions, and receiving a diet at least equivalent if not superior to that ingested by the average American child, are subject to inflammation of the gums and to dental caries. These dental disorders

either disappear, or are greatly alleviated in severity, when a pint of orange juice and the juice of one lemon are added to the standard daily diet. We have, therefore, demonstrated that dental conditions can be influenced by diet; and particularly, that orange and lemon juice contain something that a child requires for the maintenance of oral health. We feel justified in inferring that a large proportion of these dental disorders would probably not occur, if children were supplied with an adequate diet.

85. STUDIES OF ENAMEL AND DENTIN IN RELATION TO DENTAL CARIES[29]

Maxwell Karshan, M.A., Ph.D., Department of Biological Chemistry, College of Physicians and Surgeons, and School of Dental and Oral Surgery, Columbia University, New York City

Since it has been claimed that differences in "dental lymph" may constitute one of the determining factors in susceptibility to dental caries, an effort has been made to determine the nature of the material dissolved or extracted by water from powdered enamel and from powdered dentin. Successive extracts on the same specimen yield data which may distinguish between material dissolved from the solid-phase of enamel or of dentin, and salts that originate in tooth fluid.

Powdered specimens of enamel and of dentin, prepared from carious and non-carious teeth, were passed through an 80-mesh sieve. Portions of 200 mg. were added to 10 cc. of water, which had been boiled and then adjusted with bromthymol blue to a pH of 7.0. The mixture was shaken by machine for 30 minutes and centrifuged under oil, and the pH, and Ca, P, and CO_2 (from carbonate or bicarbonate) were determined; in some cases as many as seven successive extracts were made. The pH values of the enamel and dentin extracts ran from 7.3 to 7.6 and from 7.8 to 8.0 respectively, but as successive extracts were made the pH was reduced, usually reaching, for enamel and dentin, levels of 7.05 and 7.4, respectively. In the same way the Ca, P, and CO_2 contents of the extracts were maximum in the first and decreased in successive extracts, to a point at which they were

[29] Conducted with the aid of a grant from the Commonwealth Fund for research in dental caries.

indeterminable by the methods used, indicating that material originally present in small amounts was being removed. This may represent either a constituent of the solid phase that is soluble and present in small amounts, or material from enamel or dentin fluid. The analytic data in *table 9* indicate that Ca-, P-, and CO_2-yielding materials are not removed in the ratio of their occurrence in enamel or dentin. Enamel and dentin extracts from carious and non-carious teeth have been compared, but thus far no correlation has been observed. This work is being continued, and will include other water-soluble constituents.

TABLE 9

Percentage of calcium, phosphorus, and carbon dioxide removed from enamel and dentin in first extract, and percentage in whole enamel and whole dentin

MATERIAL ANALYZED	CALCIUM		PHOSPHORUS		CARBON DIOXIDE	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Enamel extract	0.010	0.022	0.031	0.042	0.030	0.040
Dentin extract	0.021	0.032	0.045	0.081	0.163	0.215
Whole enamel	35.7		17.4		2.97	
Whole dentin	24.8		12.3		3.06	

86. THE SIGNIFICANCE OF PHOSPHORUS AND THE Ca:P RATIO IN CARIES SUSCEPTIBILITY AND IMMUNITY IN EXPERIMENTAL ANIMALS

Henry Klein, D.D.S., Sc.D., and E. V. McCollum, Ph.D., Sc.D., School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Md.

The manuscript represents an analysis of the existing data concerning the relationship of diet to dental-caries susceptibility and immunity. The results of such analysis reveal many interesting facts that help to clarify the present confusion concerning the factors operating in the causation of experimental dental caries. The reanalysis indicates that many investigations aimed at the production of dental caries have resulted only in defective calcification, and that a close relationship has been postulated to exist between the two disorders. It is pointed out that, from the standpoint of definition, the two conditions possess little in common, and that from the standpoint of

pathology they bear no resemblance. The recurrent inference that food has a bearing upon dental caries does not seem extraordinary, when it is regarded in the light of the findings of nutrition studies, which have revealed that deviations from the optimal composition of the diet readily affect protoplasm. In experimental animals dietary investigations have shown defective calcification more frequently than actual dental caries. The exact dietary factors responsible for the reported dental caries are as yet unrevealed. The opinion, up to 1922, concerning the factors operating in the production of experimental caries can best be summarized as follows: "It is not possible at this time to name any one deficiency which specifically causes dental or oral disease."(1).

The reanalysis also indicates that much attention has been directed to the possibility that dental caries is due to a vitamin-C deficiency. While the fresh prominence of this theory is based upon spectacular results with humans, the earlier work that directed attention to vitamin C as a possible factor in caries was performed upon experimental animals. In ascertaining the effects of scorbutic diets upon the production of dental caries in monkeys, Howe fed mixtures consisting of wheat 35 parts; soy beans, 25; rolled oats, 22.5; Klim, 10; butter, 5; $CaCO_3$, 1.5; NaCl, 1.0 to eight monkeys, each of which developed dental caries. This diet has the following composition: Ca, 0.7905 percent; P, 0.4918 percent. The Ca:P ratio was adequate. The diet supplied vitamins B (complex), A, and some D. In fact it was adequate in all respects excepting in its intended deficiency in vitamin C. The same diet was given to three monkeys with daily additions of 10 cc. of orange juice—an adequate diet that did not cause scurvy. The three monkeys developed dental caries in spite of the vitamin-C intake. The same diet was then given to one monkey with daily additions of 30 cc. of orange juice. This monkey also developed dental caries. Thus, when an adequate diet, with or without orange juice, was given to twelve monkeys, each developed dental caries. The data also show that an adequate diet, which induces excellent calcification, did not prevent dental caries in these monkeys. Howe (2) reports additional experiments with the same diet minus $CaCO_3$, which deletion changed the composition of the diet: Ca, 0.1932 percent; P, 0.4991 percent. The Ca:P ratio is low

in Ca, high in P. This diet, supplying vitamins B (complex), A, and some D, but deficient in vitamin C—a scurvy and low-Ca rickets-producing ration—was given to five monkeys, of which one developed dental caries; four did not. These findings indicate that a vitamin-C deficiency can exist in the absence of gross dental caries, and also that factors (low Ca, high P) tending to produce defectively calcified teeth do not cause dental caries in monkeys. This striking change in monkey susceptibility to dental caries was not brought about by supplying vitamin C, but apparently by decreasing Ca in an adequate diet to such an extent as to render the diet a potentially rickets-producing one, without making any important change in the size of the food particles.

The studies of Mellanby (3) afford interesting and valuable records for analysis. She gave dogs a great variety of diets, many of which were low in Ca and high in P. One consisted of skimmed-milk powder, 20 gm.; lean meat, 10; olive oil, 1–3; lemon juice, 5 (cc.); yeast, 5; NaCl, 1–3; oatmeal, 30–150. This diet has: Ca, 0.2429 percent; P, 0.4367 percent; Ca:P ratio, 1:1.79. Dogs on this diet developed very poorly calcified teeth. Yet Mellanby reports no dental caries in any, despite the fact that their teeth were very poorly calcified. Here again the absence of caries was concomitant with a diet that induced poor calcification and was low in Ca and high in P. That dogs do develop dental caries is well recognized. Swine on diets low in Ca and high in P develop teeth that are very defectively calcified, but free from caries (4). On the other hand, as pointed out earlier, monkeys on an adequate diet that produces teeth of good calcification, may develop dental caries. Recent reports indicate (5) that rats, for a relatively long period on McCollum stock-diets, developed caries of the molar teeth in approximately 10 percent of the group. It was also found that rats on the following ration—corn 76 parts; wheat gluten, 20; $CaCO_3$, 1.5; NaCl, 1.0—developed dental caries at approximately 100 days of age in 88 percent of the group. This diet is high in Ca and low in P. These data indicate that dental-caries susceptibility is associated in experimental animals with a diet in which the P content is low, and that caries immunity is related to a diet containing a high percentage of P and a low one of Ca. Little correlation between defectively-calcified teeth and caries-susceptible teeth has been shown.

Recent work on diet and dental caries suggests the possibility that size of food particles plays a rôle in dental-caries susceptibility (6). Rats on the following stock diet—ground yellow-corn, 60 parts; whole-milk powder, 30; linseed meal, 6; alfalfa meal, 3; NaCl, 1—developed dental caries in the molar teeth at eight weeks of age. The ground yellow-corn was then sifted through a 60-mesh screen, and the portion passing through substituted for the ground whole-corn in the diet for another series of rats. The latter diet, containing 60 parts of the ground whole-corn that passed through a 60-mesh screen, resulted in an absence of dental caries in rats so fed. The authors suggest that the cause of dental decay is "the decomposition of certain food-stuffs held by the teeth in some way or other." They indicate that coarse-corn feeding results in food impaction and ensuing caries; whereas the absence of caries in rats on the fine-corn diet was due to the absence of coarse food particles and food impaction. Other workers (7) have pointed out many chemical differences between ground whole-corn and the portion of such corn that passes through a 60-mesh screen. One interesting difference is that the corn siftings fed in the experiments mentioned above (6) contained a higher percentage of P than the ground whole-corn, as follows (parts per 100 of substance): ground whole-corn, 0.295; corn siftings, 0.379. Inasmuch as the P levels in both diets (coarse and fine) were not identical, the conclusion that size of particle was the causative factor is not entirely justified. These facts are, however, consistent with the evidence already reviewed on P levels relating to dental-caries susceptibility and immunity, for dental caries was absent in Hoppert's rats on a diet higher in P content while dental caries developed in those on a diet having a lower P content. That impaction of food particles may play a rôle in caries susceptibility in rats, speaking generally, is possible, however. Indeed, histological evidence as yet unpublished indicates that food impaction plays a rôle.

Karshan et al (8) have found that salivary P is higher in caries-immune humans than in those who are caries susceptible. Also blood figures published by Kramer and Howland (9), on young rats, indicate that diets low in Ca and high in P produce high blood-P levels, while diets high in Ca and low in P produce low blood-P levels. The available data indicate that the P level in the diet, and possibly in the blood and saliva (indices of P-utilization), is related to dental-caries

susceptibility and immunity, and that the ingestion of diets low in P seems to favor caries susceptibility. The manuscript points out further that it is apparent that these data, culled from the literature, are far from serving as convincing evidence that P levels are the *controlling* factors in caries immunity and susceptibility. But these data direct attention to the possible rôles that P may play in such phenomena; indicate little correlation between structural excellence and immunity to dental caries, or between structural dental-deficiencies and susceptibility to dental caries; reveal an apparent lack of relationship between vitamin-C deficiencies and susceptibility to dental caries; and also indicate that adequate diets do not apparently afford protection to monkeys or rats against dental caries.

References to literature. (1) McCollum, E. V., Simmonds, N., Kinney, E. M., and Grieves, C. J. *Johns Hopkins Hospital Bulletin*, 1922, *33*, 202. (2) Howe, P. R. *Journal of the American Dental Association*, 1924, *11*, 1149. (3) Mellanby, M. *Medical Research Comm., Spec. Rep., Series 140*; 1929. (4) Klein, H.,McCollum, E. V., Buckley, S. S., Howe, P. E. *Journal of the American Dental Association*, 1930, *17*, 782. (5) Klein, H., and McCollum, E. V. *Journal of Dental Research*, 1931, *11*, 745. (6) Hoppert, C. A., Webber, P. A., and Canniff, T. L. *Science*, 1931, *74*, 77. (7) Klein, H., and McCollum, E. V. *Ibid.*, 1931, *74*, 662. (8) Karshan, M., Krasnow, F., and Krejci, L. E. *Journal of Dental Research*, 1931, *11*, 573. (9) Kramer, B., and Howland, J. *Journal of Nutrition*, 1932, *5*, 39.

87. FURTHER STUDIES ON THE HISTOPATHOLOGY OF DENTAL CARIES IN THE MOLARS OF RATS: CARIES IN THE ENAMEL IN RATS ON STOCK DIETS

Henry Klein, D.D.S., Sc.D., and E. V. McCollum, Ph.D., Sc.D., School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Md.

Ground sections of molar teeth of rats on stock diets indicate that enamel caries occurs in teeth showing no caries on macroscopic examination. Briefly, the lesion consists of a breaking down of enamel-rod substance, showing the transverse striations of enamel rods (*fig. 15*)—a phenomenon often noted in incipient enamel caries in human teeth. A study of a large number of ground sections indicates that incipient enamel-caries in the rat begins very frequently just below the contact point where the approximating surfaces of the molars meet. Incipient enamel-caries has also been noted in the

enamel of sulci of molars before any gross lesion could be detected macroscopically. Breaks in the dentin of the cusps of molars, which

FIG. 15. ENAMEL CARIES IN MOLAR OF RAT X 270

A—Reaction in dentin below enamel caries. *B*—Dentin. *C*—Sound enamel. *D*—Break in enamel.

are not usually covered by enamel, are often noted also, and may contribute to the total destruction of the crown that is frequently

seen in later stages of the carious process in molars of rats. The evaluation of the relative importance of the two avenues of attack on the molar-crown surfaces remains for further investigation.

88–89. BIOCHEMICAL STUDIES OF DENTAL CARIES: DIURNAL VARIATIONS IN THE PHOSPHORUS, CALCIUM, HYDROGEN-ION CONCENTRATION, AND TITRATABLE ALKALINITY[30]

88. A. UNSTIMULATED SALIVA. 89. B. UNSTIMULATED AND STIMULATED SALIVAS CONTRASTED

Frances Krasnow, M.A., Ph.D., Department of Biological Chemistry, College of Physicians and Surgeons, and School of Dental and Oral Surgery, Columbia University, New York City

An inquiry into the factors controlling dental caries necessitated a study of the composition of saliva. These reports present summaries of data showing how the P, Ca, H-ion concentration (pH), and titratable alkalinity of saliva may vary in terms of time of collection and degree of stimulation. The analyses were made on saliva of caries-immune and of caries-susceptible individuals, carefully selected from dental and medical students between 19 and 21 years old.

A. Unstimulated saliva

In order to have the subjects on practically equal physiological planes, they were instructed to rest eight hours during the night preceding each test-day; and not to wash the mouth or brush the teeth, nor to have breakfast or to smoke, before collecting the unstimulated morning sample. Another unstimulated sample was procured from each subject after the completion of classes, the same day, at 5 p.m. The data in *table 10* suggest that (1) the average content of P, Ca, H-ion concentration (pH), and titratable alkalinity were higher in the evening than in the morning for both types. (2) The percentage of cases showing increases in these constituents are respectively 66, 71, 57, and 66 for the caries-immune; 65, 73, 48, and 68 for the caries-susceptible. (3) The percentage increase in concentration of the substances taken in the same order are 17, 17, 1.5

[30] Conducted with the aid of a grant from the Commonwealth Fund for research in dental caries.

and 33 for caries-immune; 16, 11, 2.7 and 27 for caries-susceptible. (4) The percentage of cases giving a very small increase in P, Ca, and titratable alkalinity of the evening over the morning specimens is greater for the caries-susceptible than for the caries-immune. With more marked increases, the situation is reversed. Such is not the direction of change for the H-ion concentration (pH). Here, very small increases of the evening figures over the morning have more frequent incidence among the caries-immune, whereas greater increases occur more often in the caries-susceptible.

TABLE 10

Data relating to unstimulated saliva obtained in the morning and evening[1]

CASE	AVERAGE VALUES PER 100 CC. OF SALIVA				INCREASE IN CONCENTRATION OF EVENING OVER MORNING SAMPLE			
					Percentage showing increase		Percentage increase in concentration	
	Caries immune		Caries susceptible		Caries immune	Caries susceptible	Caries immune	Caries susceptible
Time sample was collected	Morning	Evening	Morning	Evening				
Phosphorus (mg.)	16.1	16.8	15.8	16.1	66	65	17	16
Calcium (mg.)	4.9	5.4	4.8	5.2	71	73	17	11
Hydrogen-ion concentration (pH)	6.94	6.98	6.86	6.92	57	48	1.5	2.7
Titratable alkalinity (cc. *N*/100 HCl)	167	181	167	192	66	68	33	27

[1] These figures are based on 52 determinations representing 11 caries-free and 14 caries-susceptible individuals. The same statement also applies to *table 11*.

B. Stimulated and unstimulated salivas contrasted

Immediately following the collection of the evening *unstimulated* sample, another specimen of saliva, *stimulated* by chewing paraffin, was obtained. The data in *table 11* seem to show that (1) there is a very definite decrease in the concentration of P in the saliva in 100 percent of both types of cases. (2) The change in Ca, although definite, is not quite so marked. The percentage of cases showing decrease is greater for the caries-susceptible than for the caries-immune, the actual decrease being less in the former. (3) The H-ion concentration (pH) and titratable alkalinity were increased after stimulation in 100 percent of the cases. However, the actual increase for the caries-

susceptibles was less than for the caries-immune. (4) The percentages of the latter showing a 20, 30, or 40 percent decrease in P, after stimulation, practically coincide with those of the former for the same increments. A similar comparison was obtained for Ca, although there is a somewhat more frequent occurrence of small decreases in the caries-susceptible. Greater decreases are found more often in the caries-immune.

No definite conclusions as to the significance of these differences can be stated at present. However, it is evident that in any comparative

TABLE 11

Data on stimulated and unstimulated salivas contrasted

CASE	AVERAGE VALUES PER 100 CC. OF SALIVA				CHANGE IN CONCENTRATION AFTER STIMULATION			
					Percentage showing change		Percentage change in concentration	
	Caries immune		Caries susceptible					
Sample	Unstimulated	Stimulated	Unstimulated	Stimulated	Caries immune	Caries susceptible	Caries immune	Caries susceptible
Phosphorus (mg.)	16.8	12.7	16.1	11.8	100	100	24	23
Calcium (mg.)	5.4	4.9	5.2	4.6	65	87	18	12
Hydrogen-ion concentration (pH)	6.98	7.43	6.92	7.35	100	96	6.8	6.5
Titratable alkalinity (cc. *N*/100 HCl)	181	333	192	294	100	84	88	75

study of salivary constituents, the collection of the salivary specimens must be made at the same time and at the same degree of stimulation.

90. BIOCHEMICAL STUDIES OF DENTAL CARIES: EFFECT OF LOW FLUORINE DIETS ON RATS[31]

Frances Krasnow, M.A., Ph.D., Department of Biological Chemistry and School of Dental and Oral Surgery, Columbia University, New York City

These experiments were undertaken to determine the role of fluorine (F) in dental caries. Eight groups of ten animals each were given the following diets:

[31] Conducted with the aid of a grant from the Commonwealth Fund for research in dental caries.

Group 1: Basal test diet + no NaF + low viosterol + carrots (0.005 percent)

Group 2: Basal test diet + 0.001 percent NaF + low viosterol + carrots

Group 3: Basal test diet + 0.0025 percent NaF + low viosterol + carrots

Group 4: Basal test diet + no NaF + normal viosterol + carrots (0.008 percent)

Group 5: Basal test diet + 0.001 percent NaF + normal viosterol + carrots

Group 6: Basal test diet + 0.0025 percent NaF + normal viosterol + carrots

Group 7: Basal test diet + 0.0025 percent NaF + normal viosterol + spinach

Group 8: Standard ration + spinach. (Control group)

The *basal test diet* consists of blood albumen, bone gelatin, Crisco, salt mixture, corn starch, glucose, and calcium lactate to give Ca:P = 2:3. In the *standard ration* were included Wheatsworth whole-wheat flour, casein, Crisco, Klim, sodium chloride, calcium carbonate, Crisco, and cod-liver oil. On a low viosterol ration, the gain in weight was 40 percent less with 0.001 percent NaF than without added F. However, 0.0025 percent NaF given to Group 3 had no greater effect on growth. Of the animals on a normal viosterol ration, those that received no F seemed to grow as rapidly as those given diets containing 0.001 percent, or 0.0025, of NaF. An interesting borderline difference between low and "normal" contents on growth effects was brought out by the fact that diet 4 (no NaF + normal viosterol) was more beneficial than, or equal in value to, diet 3 (NaF, 0.0025 percent + low viosterol). This parallelism is indicated again by the fact that the only litters born of rats on the synthetic diets were those from Groups 3 and 4. Although the newborn rats of Group 3 were greater in number, they died within three days after birth, whereas those of Group 4 are being cared for normally. The incisors of the female animals (Groups 1 and 4) are much less pigmented than those of the control group (8). The upper incisors in Group 3 are longer and less pigmented than in the controls; the lower incisors show advanced attrition. The similar findings for Group 6 are more marked. Thus far males have been affected less than females.

91. MELANOBLASTS IN THE GUM

George F. Laidlaw, M.D., Department of Surgical Pathology, College of Physicians and Surgeons, and Lester Richard Cahn, D.D.S., Department of Oral Pathology, School of Dental and Oral Surgery, Columbia University, New York City

The authors report the presence, in the human gum, of a cell not heretofore described. This cell is the dendritic melanoblast. When dendritic melanoblasts of the gum contain melanin, they are visible in unstained sections. With the usual silver stains, they are brought out more clearly. The most effective method of demonstrating melanoblasts in the gum, as in other mucous membranes and in the skin, is the "dopa" reaction introduced by Bloch (2), of Zurich.

"Dopa" reaction. The word *"dopa"* is an abbreviation for 3, 4-dioxyphenylalanin, obtainable from *Vicia faba*, a common vetch. In alkaline solution, dopa oxidizes spontaneously to a black substance closely allied to melanin, if not actually identical with it. When tissue containing melanoblasts is immersed in an alkaline dopa solution, the melanoblasts stain gray or black, the rest of the tissue remaining colorless. Bloch attributes the blackening of the melanoblasts to the presence in them of an oxidase that hastens the oxidation of dopa to melanin, which is then held by the cell that produced it. The only other cell in the human body that blackens with dopa is the myelogenous leucocyte, which also contains an oxidizing ferment.

Melanin in the mouth. In unstained, hand-cut sections, Adachi (1) observed dendritic cells containing melanin in the mucous membrane of the lower lip. He noted that they were more abundant and more prominent in brunettes than in blondes, an observation we have confirmed. Working in Bloch's clinic with the aid of silver and the dopa reaction, Becker (3) found dendritic melanoblasts in the inside of the cheek and in the laryngopharynx. He does not mention the mucous membrane of the hard palate, nor of the alveolar process of either jaw. Pigmented gum is common in animals, and is not an infrequent occurrence in the human subject. One of us (C) has observed it in Negroes, in a white Latin American, in a Hindu, and in several Hebrews of a distinctive type—dark, rather negroid in appearance, with kinky hair. The pigmentation varied from dark brown to

FIG. 16. PHOTOMICROGRAPH OF SECTION OF PIGMENTED GUM

Tissue was removed from buccal surface of gum of lower jaw, between right lateral incisor and cuspid teeth, including interdental papilla between these teeth. Caucasian Latin American. Dopa reaction. In epithelium are many dendritic melanoblasts and also melanin pigment. Melanin and melanoblasts confined to epithelium.

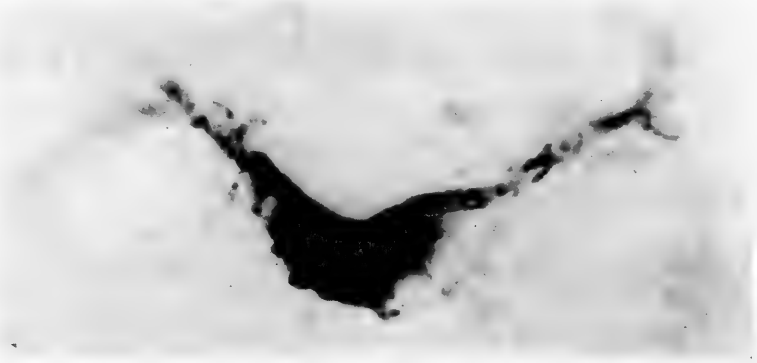


FIG. 17. OIL-IMMERSION PICTURE OF MELANOBLAST FROM SECTION IN *fig. 16*

Dendritic and granular characters plainly seen

slate color, and occurred for the most part on the buccal surface of the anterior part of the lower jaw. It has been observed also on the buccal surface of the gum of the upper jaw and on the inner surface of the lips.

While macroscopic pigmentation is sufficient evidence of the presence and activity of melanoblasts, we wished to study the non-

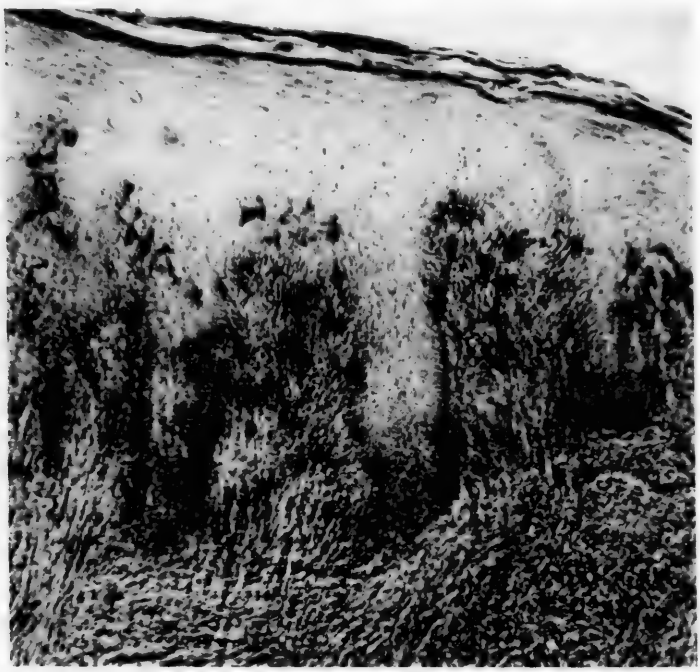


FIG. 18. DOPA REACTION OF GUM OF ANOTHER PATIENT
Note dendritic melanoblasts and melanin in epithelium

pigmented areas. Accordingly sections of non-pigmented gum were removed from various parts of jaws and subjected to the dopa reaction. In each instance the dopa sections were compared with unstained sections and with silver staining. The subjects included Negroes, Caucasians with light and dark skin, and one Caucasian with red hair and green eyes. With the exception of one case, we were careful not

to include a pigmented area in our biopsy. In every instance either melanin or melanoblasts, or both, were found in the mucous membrane of the gum. The melanoblasts are branched or dendritic and appear chiefly in the basal layer of the epithelium. No spherical forms, like those often observed in the skin, were found. We conclude that melanoblasts are a constant and normal constituent of the mucous membrane of human gum. (*Figs. 16–18.*)

Significance. Melanoblasts are found wherever melanin is being produced, or where it can be produced under appropriate stimulation. Wherever they are found, there is a potential power to form pigment and to develop malignant melanoma. The detection of melanoblasts in the mucous membrane of the gum harmonizes with the observations of pigmented areas there, and offers a rational explanation of the growth of malignant melanoma in the gum. Tumors of this type have been reported by Treves (4), Roy (5), Stewart and Phillips (6), New and Hansell (7), and others. Where pigmented areas exist in the gum, it is advisable to keep them free from the irritation of dentures and of oral sepsis.

Summary. Melanoblasts and melanin are found in normal human gum. Pigment in the gum is due to the activity of these cells. Melanoblasts are possible forerunners of malanoma malignum. It is best to keep pigmented areas free from irritation.

Bibliography. (1) Adachi, B. Hautpigment beim Menschen und bei den Affen. *Zeitschr. f. Morph. u. Anthrop.*, 1903, *6*, 1. (2) Bloch, B. Das Pigment. Handbuch der Haut- und Geschlechtskrankheiten. Band 1, T. 1; Berlin, 1927. (3) Becker, S. W. Melanin pigmentation. *Arch. of Dermat. and Syph.*, 1927, *16*, 259–290. (4) Treves, F. Melanotic sarcoma of the hard palate. *Trans. Path. Soc. London*, 1887, *38*, 350. (5) Roy, J. N. Primary melanosis of the palate. *Med. Rec.*, 1907, *72*, 730. (6) Stewart, M. J., and Phillips, J. Malignant melanoma of the gum. *Lancet*, 1922, *2*, 12. (7) New, G. B., and Hansell, F. K. Melano-epithelioma of the palate. *Jour. Am. Med. Assn.*, 1921, *77*, 19.

92. COMPARATIVE DENTAL HISTOLOGY: I. EDENTATA; (1) DASYPODIDAE; (a) DASYPUS NOVEMCINCTUS

Paul K. Losch, D.D.S., Dental School, Harvard University, Boston, Mass.

Observations have been made on the dental apparatus of a term specimen of the title classification. (*Dasypus novemcinctus*: a species

of armadillo.) The examination was made by both microscopic dissection and serial histologic sections. Drawings and photomicrographs accompany the text. The specimen was secured through the courtesy of Dr. George B. Wislocki, who presented two of the fetuses to the Laboratory of Dental Research. The dissection reveals a dental formula of

$$\begin{array}{cc} \text{I} & \text{M} \\ \frac{1|1}{1|1}, & \frac{5|5}{5|5} \end{array}$$

and seems to consist only of the primary dentition. Histological examination shows an organized dental pulp, and a stellate reticulum without an organized ameloblastic layer. This evidence of an enamel organ, which seems to be afunctional, is the most interesting observation. (To be published in the *Journal of Dental Research.*)

93. EXPERIMENTS ON THE DIETARY CONTROL OF DENTAL CARIES IN CHILDREN[32]

Ewing C. McBeath, M.D., D.D.S., B.S., Dental School, Columbia University, New York City

The report is related to experimental work, on the human nutritional phase of dental caries, from February, 1930, to about November, 1931. Dietary prevention of dental caries was accomplished in experimental and control groups of children in institutions in and near New York City. Experimental groups on "protective" diets consistently showed increased resistance to dental caries as compared with control groups. Thus far, however, the super-importance of any one dietary factor has not been demonstrated. (To be published in the *Journal of Dental Research.*)

94. PRACTICAL STUDIES IN DENTAL EMBRYOLOGY. II. METHODS OF ORIENTATION AND DETERMINATION OF PLANE OF SECTION

G. P. Matthews, D.M.D., F.R.M.S., Dental School, Harvard University, Boston, Mass.

The second paper in a series of five dealing with the practical aspect of tooth and jaw development. The first article dealt with collection

[32] Supported by a grant from the Commonwealth Fund. To be published in the *Journal of Dental Research.*

of material and methods for determining fetal age. This one outlines a method for the orientation of the selected material, and indicates how the plane of section may be determined in relation to the gross specimen. This precision technique makes it possible to locate a certain histologic plane, and to find and examine a similar plane in an embryo of a different age-group. (Published in the *Journal of Dental Research*, 1932, xii, p. 339; April.)

95. TOOTH ERUPTION VERSUS TOOTH ELEVATION[33]

Egon Neustadt, M.U.D., New York City

Tooth "eruption" refers to the relationship of the *gingiva* to the tooth. Tooth eruption starts when the tooth first cuts through the gingival tissue. Further eruption is evidenced by recession of the gingival tissues downward on the tooth crown and, finally, on the tooth root. In this way, the tooth portion that is visible in the mouth becomes larger. Tooth eruption does not stop after the tooth has made contact with its opponent. It continues as long as the tooth remains in the mouth. The state of eruption is approximately uniform on all teeth in the same person, excepting teeth that are diseased, which show a more advanced state of eruption. *Tooth "elevation,"* on the other hand, refers to the relationship of the tooth to the *plane of occlusion*. It has nothing to do with the length of the tooth portion visible in the mouth. Every tooth has a tendency to grow towards the opposing tooth. After it has thus reached the plane of occlusion, no further elevation can take place. If, however, the opposing tooth has been lost, tooth elevation may continue beyond the occlusal plane until contact is made with the alveolar ridge of the opposing jaw. In these instances the tooth portion visible in the mouth has not become longer, but the tooth and investing tissues have been carried to excessive elevation en masse. When a tooth is so misplaced as to bring it out of normal contact with its opponent, excessive elevation takes place. Owing to the frequency of extractions and malpositions, all the teeth are rarely in the same state of elevation in any mouth. Tooth *eruption* and tooth *elevation* should, for theoretical as well as

[33] Some of the work was done at the Dental School of New York University. To be published in the *Journal of Dental Research*.

practical purposes, be clearly distinguished. Many disturbances of the plane of occlusion, with which the dental practitioner is confronted, have as their etiology the continuous tooth elevation. It is impossible to institute proper treatment without a clear understanding of this etiology. Furthermore, its conception points to preventive considerations regarding the normal plane of occlusion—considerations which cannot be comprehended so long as tooth "elevation" is not thoroughly dissociated from tooth "eruption."

96. ON THE RELATIONS OF THE HUMAN DENTURE

F. H. Orton, D.D.S., F.A.C.D., and B. E. Lischer, D.M.D., F.A.C.D., A.B.O., F.A.A.A.S., College of Dentistry, University of California, San Francisco, Calif.

The basis for diagnoses of dental anomalies and dental mutilation has undoubtedly been a concept of a "normal denture," i.e., of a most favorable relationship of the teeth of man. The dental profession has formulated various concepts of these relationships, but none has ever been firmly established. Since all students entering the university must submit to a thorough medical examination, the authors took advantage of the opportunity that 2962 new students offered in August, 1930. In addition to recording the amount of overbite and overjet of the teeth of every student, we made a more comprehensive examination of a group of 51 who presented anatomically correct dentures. We included photostatic facial reproductions, gnathostatic plaster-denture reproductions, customary plaster-denture reproductions mounted on instruments based on the spheroidal theory of occlusion, three dimensional graphs, and observations of protrusive, and right and left eccentric occlusion. The report presents the findings of these examinations, and contains an adequate number of illustrations of the variations observed. (To be published in the *Pacific Dental Gazette.*)

97. NEW LIGHT ON THE ETIOLOGY AND CONTROL OF DENTAL CARIES

Weston A. Price, D.D.S., M.S., F.A.C.D., Dental Research Laboratories, Cleveland, Ohio

Investigations for fifty years on the etiology of dental caries have centered about the external and internal environments of the tooth.

The former is supported by the work of Miller, Black, Williams, Bunting, Rodriguez, McIntosh, James and Barlow. The importance of the internal environment has been stressed by McCollum, Wells, Mellanby, Howe, Hanke, and Price. No correlated experimental data adequately account for the clinical phenomena in humans. Neither immunity nor susceptibility to dental caries can be continually associated with any group of factors that have been postulated up to this time. Immunity for large groups exists under widely variable circumstances. Similarly, individual immunity and susceptibility may occur simultaneously in a small group or family. In previous communications, the author has presented data indicating that addition of activating substances, chiefly fat-soluble, to ordinary dietary programs reduced dental caries approximately 90 percent in a large group of susceptible individuals over several years. The present studies deal with the chemical and physical characteristics of the environment of the tooth, as expressed in the saliva in states of susceptibility and immunity, particularly immunity produced by the author's dietary program, designed to change both the internal and external environments.

In the author's investigations, during the past twelve years, on the relation of dental infection to systemic disease and of systemic conditions to dental conditions, including dental caries, chemical analyses—now over 2000 cases—have been made of blood, saliva and urine with progressive increase in detail. These studies—reported from time to time—have shown important divergences from normal, associated with a number of states of stress, including active dental caries and the overloads with which caries is directly associated. Our problems are not so simple as specific levels of particular chemical factors, but we deal with forces behind these chemical levels, some of which, with a contributing overload, aid the body to meet emergencies with the chemicals readily available in the nutrition. Thus of two individuals, one with a poor capacity for adaptation for overload might show levels for serum Ca, P, and Mg quite different from another with excellent capacity for adaptation, often including as one phase ability to borrow minerals from the storage depots of the skeleton. It has been noted, however, that such factors as the diffusibility of Ca and P, and the solubility factor of the blood serum for bone, not only vary

widely but are very markedly associated with physical and clinical factors. When bone chips were added to blood serum of normal individuals, from 30 to 50 percent of the serum-Ca was transferred to the bone particles. As cases depart from normality this factor is reduced and conditions associated with marked decalcification may have a very small percent of Ca in the serum. In a small percentage of cases of very great stress, Ca moved in the opposite direction; namely, from the bone chips to the serum. Similarly, 30 to 50 percent of the inorganic P—as in the case of Ca—in normal individuals has moved from the blood serum to the bone chips. In conditions of disturbed nutrition, the P has been much less reduced in amount than the Ca. In a large percentage of cases showing marked tendency to decalcification, P moved in the opposite direction; namely, from the bone chips to the blood serum. For example, in a case of marked decalcification, with many spontaneous fractures and a history of nutritional stress, the serum Ca was reduced about 17 percent, the Ca having moved to the bone chips, whereas 70 percent of the amount of the blood inorganic-P moved from the bone chips to the serum. In a group of fifty patients, having no marked tendencies to decalcification, the serum Ca fell to an average of 27 percent, and the serum inorganic-P fell 18 percent. In ten individuals having marked decalcification tendencies, the fall in serum Ca was 24 percent; the serum inorganic-P rose 28 percent.

When individuals with marked disturbance in the movement of inorganic P, associated with clinical disturbance, were placed on a nutritional reinforcement of the fat-soluble activators as obtained from a high-vitamin butter, and an exceptionally high-vitamin cod-liver oil, there was in general a marked shift toward normal in the solubility factor of the blood for these minerals. For example, in a case of spontaneous fracture with marked evidence of general skeletal decalcification before treatment, there was a fall in serum Ca of 32 percent, but a rise in serum inorganic-P of 35 percent. After being on the treatment for sixty-one days, the fall in serum Ca was 40 percent; for serum inorganic-P there was a reversal from a rise of 35 percent to a fall of 15 percent. Another instructive case was one of degenerative arthritis associated with a marked tendency to pyorrhea. Before

treatment there was a fall in serum Ca of 40 percent, and a rise in serum inorganic-P of 11 percent. After a 24-day treatment, the serum inorganic-P fell 34 percent; the serum Ca, 34 percent.

These factors of solubility for Ca and P have been expressed in the saliva in a way to bear directly on susceptibility to caries. Under this treatment, these factors have rapidly changed toward normal. A critical study has accordingly been in progress on the characteristics of the saliva, as related to immunity and susceptibility to dental caries. A quantity of information is now available relating susceptibility and immunity to these factors, and relating these factors to nutritional treatment, for a large number of cases in clinical practice. The data indicate that this abnormal movement of P, with or without a reduced fall in Ca, is apparently directly associated with susceptibility to dental caries; that the nutritional reinforcement the author has been using for some years is capable of changing these factors in a short time, often within a week; that this improvement in every case has seemingly been associated with an increase in immunity to dental caries. A group of about thirty children having very active dental caries was selected from a district of the city near the steel mills, where the parents have been seriously suffering from the industrial stress since the closing of the mills. In order to assist these children in their general nutritional stress, and also reduce their marked susceptibility to dental caries, they were given daily one specially well-reinforced though very inexpensive meal, as designed by the author and prepared by the staff of the Broadway Methodist Episcopal Church, at 5246 Broadway, of which Reverend Edwin A. Brown is pastor and director. These studies have included roentgenograms of the teeth, chemical analyses of the saliva, and a physical examination before beginning the treatment. The average change in salivary Ca and inorganic P, on the addition of bone chips, showed the Ca was approximately normal, and a fall of 38 percent. The inorganic P, however, rose 37 percent. Samples of saliva were taken from some of the group each week. They showed a rapid change in the P content, even in one week, from a rise, on addition of bone chips, of 37 percent to a fall of 3 percent. There was progressive improvement. The second week there was an average fall of 4 percent in the P; the third, a fall of

6 percent; the fourth, a fall of 17 percent. About this time epidemic "flu" invalided some of the children. The fifth week, the fall of inorganic P stood at 14 percent; the sixth, the fall was 6.3 percent.

Many other chemical factors were determined routinely, several of which showed improvement. The total P of the saliva, under the reinforcement of one specially good meal a day, increased from 45.5 mg. per 100 cc., expressed as P (144, expressed as H_3PO_4), to 65.5 mg. (207, expressed as H_3PO_4). The ratio of salivary Ca to inorganic P changed from 0.8 to 1.54. In six weeks, despite the "flu," there was an average gain in weight of 3.3 pounds. Most of the open caries-cavities were filled. Some operations were frankly experimental, and under ordinary conditions would scarcely be justified where the roentgenographic evidence indicated decalcification to the pulp. Under this nutritional program, many of these teeth were able to build-in a defensive wall within the pulp chamber. This is not a reduction in the size of the cavity, but a reduction in the size of the pulp chamber. However, caries in many unfilled cavities ceased to be active. Acidophilic bacteria were found in all mouths having caries.

Summary. These data suggest (1) why the surface density of teeth normally increases within a few months after eruption; (2) why in cases of physical stress, such as sickness, pregnancy, and grossly deficient nutrition, there is enamel softening followed by hardening after the termination of the overload; and (3) how protected tooth surfaces may be prepared for bacterial attack when the factor of safety of the entire mouth is sufficiently lowered by the reversal of the direction of movement of some of the minerals in the saliva. (4) Evidence is presented indicating that both the external and internal environments of the teeth are controlled by obscure nutritional factors, which can be supplied.

The detailed report will be presented before the New York State Dental Society (May, 1932), and is expected to appear in the *Transactions* of that Society. That report includes detailed nutritional programs, chemical methods, and means for a practical application of the program for the control of dental caries; also data from cooperating groups in a number of American and Canadian cities.

98. EVIDENCE OF A NEED FOR FLUORINE IN OPTIMUM AMOUNTS FOR PLANT AND ANIMAL GROWTH, AND BONE AND TOOTH DEVELOPMENT, WITH THRESHOLDS FOR INJURY

Weston A. Price, D.D.S., M.S., F.A.C.D., Dental Research Laboratories, Cleveland, Ohio

One of the major problems of dental research for the past three decades has involved phases of hypoplasia of different types. In 1913 the author published an illustrated report presenting an extended series of structural tooth defects, which seemed traceable directly to particular types of baby food. Black and McKay, in 1916, presented data relating to an endemic deformity of tooth structure chiefly expressed as "mottling" and "stain" which has come to be known as the "brown-stain mottled-enamel lesion." McKay's work through the succeeding years has emphasized the relation of this lesion to the water supply. Paleopathology, and medical and dental annals have been recording the existence of this disease. The recent studies of Churchill, Smith, and others have emphasized the probable relationship of this lesion to excess of F in the water. The widespread distribution of this lesion throughout large areas of many countries has emphasized the seriousness of the defect, and the probability that the causative factors will be found in soil conditions. The present studies have been carried forward to ascertain the method by which F acts when injurious effects are produced. The author's studies of blood chemical-changes, as associated with disturbances in mineral metabolism, have emphasized the sensitiveness of the human mechanism not only to shortage of essential minerals and vitamins, but also to toxic quantities of certain metallic and non-metallic substances. These have suggested the need for information on the influence of F on mineral metabolism, and on growth for both plants and animals.

Much of the F of the earth's crust occurs in apatite and other Ca-P compounds, being frequently associated with Ca and P. Since approximately one part in a thousand of the earth's crust is P and approximately an equal amount is F, there is no scarcity of either element in the igneous rocks from which soils are developed. There is about thirty times as much Ca as either F or P in the earth's crust. The

problem of the chemical form and solubility of F, as compared with other elements, has much to do with its concentration and availability for serious effects. The various phosphate rocks that are used as fertilizers—primarily calcium phosphate—contain from 0.69 to 4.23 percent of F, which is about one-tenth the P content. The ratio of F to P_2O_5, as reported by Marshall, Jacob and Reynolds in an extended series of determinations, ranged from 0.06 to 1.32 for continental rocks; from 0.0178 to 0.085 for island deposits. The solubility of F is accordingly an important factor in determining the amount available in various waters and soils. Since igneous rocks are about equally rich in P and F, our problem clearly is not one of limited distribution of F. CaF, or fluorite, a common mineral, occurs in abundance in many districts, and is soluble to 37 parts per million of water. Other F salts, such as NaF, and sodium silico-fluoride (Na_2SiF_6) are also soluble—the former, 400 parts per ten thousand; the latter, 65 parts per ten thousand. F presumably has constantly been a factor in the environment of plant and animal life. Since living forms are the product of their environment, F has presumably had a part in vital phenomena. Its low solubility in the forms in which it occurs in igneous rocks suggests that it has not been present in high concentration in surface waters. These studies have accordingly been made to determine the effect of F on plant and animal growth; and on the levels at which it becomes toxic in the water bathing the plant roots, and when ingested by animals in water and food. Various types of plants have been grown in different nutrient fluids in which the concentration of F was varied up to 25 mg. per liter. F as NaF, added in progressive amounts to sprouting corn—when the plant is utilizing only the stored minerals of the kernel, while growing in distilled water—had a progressive stimulating effect up to 10 parts per million of the water; 20 parts, or more, were very toxic and produced only stunted growth with a bronzed appearance. When, however, Ca and P were added to the fluid, the toxic effect was very greatly reduced. The maximum concentration (37 parts per million) of CaF_2 (the common mineral fluorite) would, if present, prevent this cereal from sprouting; and if it occurred in irrigation waters, would markedly depress plant growth. Surface drainage cannot readily become

saturated. Water stored in soil and rocks as artesian water can more nearly do so, and has frequently been found to blight plant growth.

Studies have also been made of the effect on mineral metabolism when F is ingested by rats. In general several chemicals were depressed. The total iron of the blood of a control rat was at 50 mg. per 100 cc. (The succeeding numerical data for rat blood indicate mg. per 100 cc., when not given as percent.) When F was added as Na F (1 percent of the food), the iron content of the blood was 42.5 mg. The cell-Ca of the blood was reduced from 41.7 percent to 35. The inorganic P of the serum was reduced from 6.67 to 5.26; of the serum of 100 cc. of whole blood, from 3.89 to 3.42; in 100 cc. of blood cells, from 0.67 to 0.22; in the cells from 100 cc. of whole blood, from 0.28 to 0.08. The cell inorganic-P percent of the total-blood inorganic-P was reduced from 6.7 to 2.3. The inorganic P of whole blood was reduced from 4.17 to 3.50; the Ca of whole blood, from 9.35 to 7.80. The Mg of blood rose from 2.63 to 3.50. The K of whole blood was reduced from 322 to 267. These data indicate that 1 percent of NaF (diet) caused general disturbance of mineral metabolism. They also suggest that ingestion of F, in amounts above the threshold of tolerance of the tissues, may be very depressing, and may materially influence mineral deposition in bones and teeth. Since, however, the teeth differ from the bones, in that a complete rebuilding process is not possible for the teeth through subsequent months and years, defects of the enamel would be permanent.

Field studies gave important data on waters and soils from many districts, including one in Northern Africa where the teeth of humans, and also those of camels, sheep, cows, goats, donkeys, and horses, are seriously affected. The waters from this district contain from 23 to 31 parts of F per ten million, determined by the Jacob and Reynolds method. The rocks from this district contained 5.38 percent of F, or 53,800 parts per million. This is the highest figure in our series, and higher than any found in the literature. Another series is related to the skeletal breakdown of a group of cattle on a western farm, where both the water and the soil contain excessive amounts of F. The blood of afflicted animals showed very marked depression of mineral constituents.

99. EXPERIMENTAL INVESTIGATIONS OF THE CALCIFICATION PROCESSES IN BONES AND TEETH

Friedrich Proell, M.D., D.M.D., Medical School, University of Greifswald (with the coöperation of Dr. Dienen), Greifswald, Germany

The investigations deal with the following questions, including an interpretation of the findings: (1) What are the forms in which Ca-salts in general occur in the blood? (2) In which form is the Ca that is involved in bone construction present in blood serum? (3) How can one demonstrate, by simple methods, that this Ca constituent of the blood is present in ionized form? (a) By electrolysis of serum. (b) By electrolysis of a decalcified ground-section of bone acted upon by serum. (c) By electrolysis of bone in the process of calcification. (To be published in the *Journal of Dental Research.*)

100. HISTOLOGIC CHANGES IN THE RAT MOLAR FOLLOWING HYPOPHYSECTOMY

I. Schour, B.S., D.D.S., M.S., Ph.D., Department of Dental Histology, University of Illinois, and Department of Anatomy, University of Chicago, and H. B. Van Dyke, Ph.D., M.D., Pharmacological Laboratory, University of Chicago, Chicago, Ill.

This study is based on twenty-two hypophysectomized rats, their ages, when operated upon, ranging from 36 to 64 days. The interval between operation and death ranged from 63 to 459 days. These animals had been used for a study of the hypophysectomy-changes in the rat incisor (*Journal of Dental Research*, 1931, xi, p. 873; Dec.). A study was also made of fifteen litter-mate controls, most of which were unsuccessfully hypophysectomized. The gross findings relating to the molars were (a) slightly retarded eruption; (b) shorter length of roots; (c) wider pulp-chamber and pulp-canal. The histologic findings are summarized below:

(1) The *epithelial attachment* is absent in a number of cases for varying lengths near the cemento-enamel junction, the enamel being bounded directly by connective tissue or by a cementum spur of varying length and width. In eight animals the enamel here shows some areas of resorption. (2) The *enamel* is normal in structure excepting at areas of resorption near which the organic matrix is sometimes seen in spite of decalcification. (3) The *dentin* as a whole

appears normal in structure. It is resorbed when the resorption of the enamel or cementum has extended beyond the dentin boundary. (4) The *pulp* usually shows a reduced blood supply—in some cases, advanced atrophic changes—and contains calcified globules. The size of the pulp chamber and pulp canal is larger than normal. (5) The *cementum* shows an abnormal frequency of resorption, which is most prominent at the bifurcation level; least, at the apical portion of the root. In some of the animals of longest post-operative life, a great number of globules of various sizes that stain like cementum are seen at the cementum surface, which faces the periodontal membrane. In some cases the periodontal membrane contains similar but larger globules, which appear to be arranged in the direction of the periodontal membrane fibers. Cementum apposition is continuous throughout the entire postoperative life. (6) The *periodontal membrane* contains an abnormal increase in the number of epithelial rests. These are usually proliferative and larger than normal. In advanced cases some of them form into small cysts or become calcified. The blood supply is below normal. (7) The *alveolar bone* shows an increased number and crowded arrangement of cementing lines. Bone apposition is continuous throughout the entire post-operative life.

The actual conditions in a given case are progressive and thus depend on the time elapsing between the operation and the death of the animal. (To be published in the *Journal of Dental Research.*)

101. FACTORS IN BONE REGENERATION OBSERVED IN EXPERIMENTAL WORK ON JAWS IN DOGS

Warren R. Schram, D.D.S., M.S.D., and Harold G. Worman, D.D.S., Research Laboratory, Dental School, University of Minnesota, Minneapolis, Minn.

Wolf was one of the first to call attention to the fact that the architecture of bone is that best adapted to meet the demands of stress and strain. In a cross section of the head of a femur, we see compact bone and bone platelets as nicely arranged, to meet the strains to which the bone as a whole is subjected, as are the steel girders in our most modern constructions. This same architectural perfection is present throughout the entire bony skeleton. Sections through a jaw show that this fundamental principle of bone architecture is constantly applied. Here the bone platelets and dense subperiosteal bone are arranged not

only to meet the demands of stress and strain from muscular action, but also to provide for the stress of mastication as it is transmitted through the teeth. This architecture constantly changes to meet changing conditions. When teeth are lost, the functional demand is different and the architecture is altered (MacMillan). It appears, then, that if teeth are lost, or the bony process otherwise injured, two natural processes are promptly set to work: (a) bony repair and (b) rebuilding of the area with a bony architecture best suited to meet the new functional demands. An 8-day extraction-wound in a dog's jaw shows that nearly all the activity within the wound is that of repair. In the center is a well organized clot containing well-formed connective tissue. Along the lower margins are areas of very early bone formation. And yet, at the margin of the socket, progressing simultaneously with new bone-formation, are areas of destruction in the original bone—a breaking down of bone at the orifice of the bony socket. In a slide made from a section in which the periosteum was raised and held by means of a silver ring, the bone is built out to the elevated periosteum. Here the mandible was not weakened. There is no reason for the new bone-formation except the stimulus from the elevated periosteum. If, after this area of bone were fully formed, the silver ring should be removed, it is probable the added bone would eventually be absorbed.

Nature apparently uses repair and rebuilding processes in the order of their importance in a given case. In a slide illustrating this view may be seen heavy plates of new bone built under the periosteum on either side of a dog's mandible, which had been greatly weakened by the surgical removal of several teeth. Here the rebuilding process predominates. The further investigation of bone repair, with particular reference to the two definite processes at work simultaneously, is an interesting and, we believe, a productive field.

102. "BONE DESTRUCTION," WITH SPECIAL REFERENCE TO GROWTH OF BONE TUMORS

Warren R. Schram, D.D.S., M.S.D., and Harold G. Worman, D.D.S., Research Laboratory, Dental School, University of Minnesota, Minneapolis, Minn.

We have been interested in the study of various mechanisms by which tumor growths make room for themselves in bony tissue. The processes in all tissues are basically the same under similar conditions.

Variations in reaction to a given irritant are due only to structural differences. Bone is a derivative by adaptation of connective tissue. This and the predominance in bone of inorganic materials, are conditions that we have kept in mind in this work. In reviewing a group of slides, three general pictures presented: (a) the cortical plate appeared to be simply pushed aside by the growth, with no apparent bone destruction; (b) the bone was apparently being destroyed by an inflammatory process secondary to the invasion of the tumor; (c) there is no evidence that the cortical plates were being pushed aside, nor is an inflammatory process indicated, yet the bone is not present where it normally should be. It seems reasonable to suppose that this type of destruction is caused by a local disturbance in the Ca and P balance. We have not observed any factors in bone destruction, associated with tumor growth, that are peculiar to this condition alone.

103. FUNDAMENTAL PRINCIPLES OF CLINICAL PHOTOGRAPHY

Frederick W. Schubert, D.D.S., College of Dentistry, University of California, San Francisco, Calif.

Photography is an indispensable aid in the field of applied science. In dentistry, its application has been rather limited; usually, it has been applied in an indefinite and unscientific manner. In this paper some fundamentals applicable to clinical photography are discussed; for example: anomalies of perspective; lenses and their fundamental formulæ; principles of illumination; types of film emulsions. A photostatic camera of recent design is also described. Photographs are taken under predetermined, standardized conditions, so that these photostatic facial reproductions can be utilized for desirable metric measurements and evaluation. It is also possible to coördinate the photostatic facial-reproduction with the plaster-denture reproduction, so that photographs taken under these conditions are an accurate scientific diagnostic aid. (To be published in the *Pacific Dental Gazette*.)

104. AN ANATOMICAL PATH FOR INFRA-ORBITAL INJECTION

H. J. Sedwick, D.D.S., Rockefeller Fellow in Dentistry, School of Medicine and Dentistry, University of Rochester, Rochester, N. Y.

On this anatomical path, the needle follows the connective-tissue sheath or fascia separating the superficial from the deep muscle-layer

of the labial-orbital region. The needle enters the fascia at the point of separation of the two muscle layers over the cuspid tooth, taking an upward course to the foramen, at an angle of approximately 45°, to the median line of the face, passing between the caninus and the infra-orbital head of the quadratus labii superioris muscle, distally to the infra-orbital head and mesially to the zygomatic head. The fascia is stretched and held taut during this injection. By following this path the nerve can be anesthetized without the operative pain and post-operative soreness that result from muscle puncture.

105. STUDIES OF THE METABOLISM OF FLUORINE. I. EFFECT OF SODIUM FLUORIDE IN THE DIET UPON THE CHEMICAL COMPOSITION OF THE INCISORS OF ALBINO RATS

Margaret Cammack Smith, M.A., M.D., and Edith M. Lantz, B.A., M.A., Department of Human Nutrition, University of Arizona, Tucson, Ariz.

The establishment in this laboratory of the presence of fluorides in drinking water as the cause of mottled enamel has led to a study of the metabolism and mode of action of F. The changes in the incisors of rats produced by ingestion of NaF include such gross abnormalities as loss of normal orange pigment, dull-white opacity, corroded and pitted enamel, and overgrowth or excessive abrasion of these teeth, all indicative of marked alteration in structure and composition. No chemical analyses of mottled teeth of persons or of fluoride-fed rats appear to have been made. McClure and Mitchell,[34] working with bones of fluoride-fed rats, reported a possibly significant increase in percentage in ash, decrease in percentage of Ca in the ash, and also depression of the ratio of Ca to P therein. In our experiments to determine effects of NaF on the chemical composition of teeth, albino rats, taken at the time of weaning, were placed upon an adequate basal ration—Sherman's Diet "B"—to which we added NaF (0.05 percent), which at this level had previously been found to produce outward changes in the incisors similar to those of mottled enamel in human teeth. Litter-mates were continued as controls upon the same basal ration, minus NaF. In 60 or 120 days, the animals were chloroformed. One

[34] McClure and Mitchell: *J. Biol. Chem.*, 1931, xc, p. 297.

upper and one lower incisor from each rat were used for chemical analysis; the other pair was saved for histological examination. To reduce the percentage error in the chemical determinations, and the variations due to differences in the teeth of individual rats, composites of the teeth of four rats were prepared for analyses as follows: the material was extracted, for two 9-hour periods, with fresh boiling 95-percent alcohol, followed by two 9-hour extractions with boiling anhydrous ethyl-ether. The fat-free material was dried in a Freas

TABLE 12

Data on the composition of incisors of rats on a diet containing sodium fluoride

A. 60-day experimental period

RATION	NUMBER OF RATS REPRESENTED	WT. OF DRY TEETH (4)	ASH; ±P.E.*	Ca IN DRY TEETH ±P.E.	Ca IN ASH ±P.E.	P IN DRY TEETH ±P.E.	P IN ASH ±P.E.	Ca:P RATIO ±P.E.
		mg.	*percent*	*percent*	*percent*	*percent*	*percent*	
Basal ration + 0.05 percent of NaF.....	44	451.1	77.4 ±0.10	29.0 ±0.24	37.8 ±0.26	14.9 ±0.54	19.1 ±0.054	1.96 ±0.014
Basal ration (controls).....	48	468.5	77.7 ±0.06	29.2 ±0.32	37.7 ±0.36	15.1 ±0.11	19.3 ±0.16	1.95 ±0.01

B. 120-day experimental period

Basal ration + 0.05 percent of NaF.....	12	568.9	78.1 ±0.01	28.1	36.7	14.8	18.8	1.91 ±0.02
Basal ration(controls).....	44	570.0	78.1 ±0.19	28.6 ±0.17	36.9 ±0.26	14.7 ±0.08	18.9 ±0.10	1.93 ±0.016

* "P.E." = probable error.

electric oven at 100°C. to constant weight; then ashed in a muffle furnace; and the ash dissolved in 1:1 hydrochloric acid (100 cc.). Aliquots of this solution were taken for analyses. Ca was determined by the method of McCrudden, and P by the colorimetric method of Fiske and Subbarow. Average results already obtained are shown in *table 12*.

It is quite evident that no significant differences in percentage of Ca or P, Ca:P ratio, or percentage of ash in the incisors of the fluoride-fed animals, as compared with their controls, have been revealed by these

analyses. The large number of animals used and comparisons made, and the consistency of the analyses as indicated by the small probable error of their means, show clearly that the results are correct. Changes in Ca and P contents of the teeth, suspected from the observed outward abnormalities and suggested by the histological study of Chaneles,[35] are apparently too slight to be revealed by chemical analyses as usually made.

106. THE CONCENTRATION OF FLUORINE IN DRINKING WATER IN RELATION TO THE OCCURRENCE AND SEVERITY OF MOTTLED ENAMEL IN HUMAN TEETH

Margaret Cammack Smith, M.A., Ph.D., and H. V. Smith, M.S., Agricultural Experiment Station, University of Arizona, Tucson, Ariz.

In 1931 we reported the experimental production, in rats, of an enamel defect similar to mottled human enamel, by addition of NaF to the ration, and also by the inclusion in the diet of residue from the drinking water of St. David, a community in which mottled enamel is endemic. Since then, mottled enamel has been produced in dogs by adding NaF to the diet, and in rats by subcutaneous injection of fluoride. Subsequently, the presence of abnormal amounts of F in the water supply of several endemic communities, including St. David, was revealed. The work of Gautier has shown that fluorides are widely distributed in drinking waters. Rock phosphates, which normally contain approximately 3 to 4 percent of F, are also widely distributed in nature. We present further evidence on the relation of F in drinking water to the occurrence of mottled enamel, and on the concentration of F in potable water that prevents normal enamel development. During the past year investigations, still in progress, have determined existing conditions in Arizona, and have made it possible not only to determine the endemic and non-endemic areas in the state, but also to correlate the concentration of F in the potable water with the existing degree of mottling.

Practically every community in the state with a population large enough to warrant investigation was visited, and the occurrence or

[35] Chaneles: Estudios sobre el fluor y la fluorosis experimental, pp. 146. Escuela de Odontologia, Buenos Aires; Imp. Ferrari Hnos, 1930.

absence of mottled enamel in the community recorded. The permanent teeth of the children in the public schools were examined. Only those who were native to their individual communities, that is, had been exposed to the environmental factors of that community since infancy, were considered in judging the local prevalence of mottled enamel. The water supply of each community was sampled at the time the tooth examination was made. Care was taken to ascertain that there had been no recent change in the source of water, so that the water sampled could be justly correlated with the tooth condition. Originally the laboratory analyses of many waters for F were made with a modification of the volatilization method of Jacobs, Ross, and Reynolds. However, as this method did not lend itself well to routine determinations, the results presented here were made with a modification of Fairchild's ferric-chloride method, which seems to give somewhat higher and perhaps somewhat less accurate results, but which, if certain precautions are carefully observed, yields reliable data. Approximately 110 public water supplies, and 55 private, in this state have been analyzed. A detailed report of the findings for each community will be published as a technical bulletin of the Arizona Agricultural Experiment Station before July 1, 1932. The following conclusions are indicated:

There are at least 45 communities in Arizona in which mottled enamel is endemic, in degrees varying from "very mild" to "severe." Most of these communities lie along two rivers; namely, the Gila and the San Pedro, the latter flowing into the Gila. There was no observable relation between the origin of the water—dug well, shallow or deep artesian well, or spring—and its F content. Waters from different parts of the state showed F contents varying from 0 to 15 parts per million. Endemic communities in which the mottling was "severe" used water having F concentrations of more than 5 parts per million. In these communities the entire surface of the tooth was defective in its formation, and there was considerable staining ("brownin"). F concentrations from 2.7 to 4.0 p.p.m. were associated with less severe mottling, although a marked degree was consistently observed. Waters having F contents of 1.3 or less p.p.m. did not cause mottling. Fortunately, the most populated districts in Arizona fall within this class. Waters with F contents of 1.5 to 2.7 p.p.m.—"border-line

concentrations"—were variable in effect. In some persons they were associated with mottling of a very mild type, chiefly characterized by a consistent though irregular distribution of white, non-translucent areas on all the teeth. In other persons no evidence of mottling was observed. This difference in the results was probably due to variations in individual susceptibility. At the higher levels of F concentration, however, the defect, in different degrees of intensity occurred in all children, regardless of race, color, or creed.

Analyses of waters from some endemic communities in other states, including California, Oregon, Idaho, New Mexico, Kansas, and South Carolina, have shown a F content varying from 4.5 to 17.0 p.p.m. Fluorides, although normally widely distributed, occur in the potable waters in certain parts of the world in concentrations that are toxic to normal enamel-development. Our observations show that concentrations in excess of 2.5 p.p.m. certainly cause mottling in pronounced degree, the severity increasing with the concentration. "Mild" to "negative" mottling among different individuals was associated with F contents between 1.5 and 2.7 p.p.m. None of the Arizona waters having F contents below 1.5 p.p.m. were associated with mottled enamel. Prevention of mottled enamel, which necessitates a change in water supply, involves a serious economic problem for the afflicted communities. Practical methods for the removal of F from public water-supplies are being investigated in this laboratory.

107. CHANGES IN THE INCISORS OF RATS FED A RATION DEFICIENT IN VITAMIN A

Margaret Cammack Smith, A.M., Ph.D., and Edith M. Lantz, B.A., M.A., Department of Human Nutrition, University of Arizona, Tucson, Arizona

Changes in the incisors of rats on a diet deficient in vitamin A have been repeatedly observed in this laboratory. Hand in hand with cessation of growth and appearance of ophthalmia, which result from vitamin-A deficiency, there is loss of the normal orange-pigment of the incisors, which become dull-white and opaque. Decrease in hardness is indicated by excessive abrasion, the lower incisors especially becoming shorter and blunt. Litter-mates receiving the same basal ration, with a daily addition of three drops of cod-liver oil, did not show these changes. The dull-white incisors of vitamin-A

deficient animals regained their normal pigmented translucency after addition of cod-liver oil to their daily ration. That these abnormalities are due to a vitamin-A deficiency is inferred from the fact that the ration used is supposedly adequate in all respects except vitamin A, and the changes in the incisors begin to be noticeable when cessation of growth and infection of the eyes give evidence of the exhaustion of the animal's stores of vitamin A. The observed changes were not prevented by irradiation of the animals, nor by daily feeding of one-half drop of 100D Viosterol in addition to indicated cholesterol in the basal ration. On the other hand, the incisors were normal in appearance when vitamin A-rich alfalfa or butter-fat was added to the basal ration. Chemical analyses of the incisors of both the vitamin-A deficient animals, and their litter-mates that received cod liver oil, gave the

TABLE 13

Data on the chemical analyses of incisors (averages)

RATS	WEIGHT OF DRY INCISORS	ASH	Ca IN ASH	P IN ASH	Ca:P RATIO
	mg.	*percent*	*percent*	*percent*	
Vitamin-A deficient (at death)	179.7	76.3	42.2	19.0	2.17
Received cod-liver oil for 60 days; litter-mates	221.6	77.8	37.9	20.2	1.86

results shown in *table 13*. A higher percentage of Ca and lower percentage of P in the ash of the vitamin-A deficient incisors, with a resulting higher Ca:P ratio, were noted. Addition of vitamin A, in cod-liver oil, lowered the percentage of Ca and accordingly the Ca:P ratio. This suggests the possibility that the decrease in hardness of the teeth, and their lessened resistance to wear, may be due to a decrease in the proportion of Ca that is deposited in combination with the phosphate radical, and to an associated increase in the proportion deposited as the carbonate or in some other combination.

108. THE INFLUENCE OF RAW MILK ON TEETH[36]

Evelyn Sprawson, M.C., L.R.C.P., M.R.C.S., L.D.S., London Hospital, Dental School, University of London, London, England

Two or three years after a daily ration of a pint of raw milk had been issued to a collection of some 750 boys, it was noticed that once they

[36] Read at a meeting of the London Section of the International Association for Dental Research, March 9, 1932. Published in the *Proceedings of the Royal Society of Medicine (Section of Odontology)*, 1932, xxv, p. 11; March.

had had dental treatment there was subsequently a remarkable diminution, almost to absence, of "return" work for dental caries. This prompted an investigation into the possible effects of raw milk given daily and commenced before the age of twelve months, i.e., before the eruption of the deciduous molars, which are very prone to caries. Forty such children were found who are now of an average age of 4 years: they had no incidence of dental caries. None were under 2 years when examined. The dietary of most of them consisted, amongst other things, of oatmeal porridge or quaker oats daily for breakfast, milk puddings and custard for dinner, always followed by the giving of one or two "boiled" sweets. Two control investigations were made at later ages. In one case, 33 children commenced raw milk at an average age of 1 year 9 months; they are now 4 years old. In the other, 28 boys commenced it at an average of 4 years 8 months, and are now aged 8 years 10 months. It was found that in the 61 children involved in these controls, though teeth erupted before raw milk had been started were carious, all those erupted after its commencement, excepting in 3 children, were caries free. Investigation showed that in each of these 3 exceptional children, there were circumstances which either cast doubt on the date of commencement of the raw milk, or necessitated prolonged absence from it up to about, or even after, the time of eruption of the teeth involved. A further control of 44 boys, who started raw milk at the average age of 9 years 11 months, and are now aged 14 years 3 months, showed that protection of the second permanent molar was incomplete, possibly because it was not commenced till an age when it can no longer be regarded as a physiological food; though it was seen that there was a considerable degree of protection of this tooth when this group was compared with two other groups of similar ages who had (a) pasteurised milk and (b) pasteurised milk plus cod-liver oil, respectively.

Comparison with primitive peoples, who have a lesser incidence of caries, indicates that the period of maternal or raw-milk feeding is much curtailed in civilised communities. A comparison with wild animals further emphasises this, these last being mostly caries free. Investigation has also indicated that the primitive races of the world showing the smallest incidences of caries have been those which suckled their children for the longest periods, i.e., fed them on raw

milk. Raw cow-milk seems to be an efficient substitute for the child's physiological food insofar as the forming of enamel having some immunity to dental caries is concerned. It is not known how long this immunity lasts. This same regimen, when commenced early in life, seems to cause a marked diminution in the need for operation for removal of adenoids and enlarged tonsils.

The great majority of the children examined for these investigations were subnormal physically or suffering from disabilities, in some cases grave, before the raw milk was commenced, and these disabilities were such as are known to cause variations in calcified dental tissues believed by many to predispose them to dental caries. The investigation also shows conclusively that teeth having a considerable degree of immunity to dental caries may be developed entirely independently of ante-natal care.

109. A SYSTEM OF ORAL EXAMINATION FOR RESEARCH PURPOSES

"Toronto Oral-Research Group," Director, R. Gordon Agnew, B.A., D.D.S., F.I.C.D., Toronto, Canada

In connection with an extensive investigation now in progress in Ontario, in conjunction with the Department of Pediatrics of the Faculty of Medicine, and with the Faculty of Dentistry, University of Toronto, relative to the inter-relationships between the incidence or prevention of oral lesions and state of nutrition of the individual, a system of examination of mouths of human subjects for research purposes has been elaborated, involving the following features. (1) General data as to intra-oral and extra-oral conditions are recorded on a special chart. Extra-oral information, for example, includes detailed condition of skin, lips, glands, etc. (General physical-examination records are made by the coöperating medical group. This includes, in certain instances, estimations of Ca and P in the blood.) (2) Complete radiographic studies are made of each individual in the control group and the group under investigation. This, of course, includes full bite-wing technique, without which no examination of interproximal areas would be adequate. (3) Complete impressions of each mouth are taken in Dentocoll, and casts prepared, with adequate marking of data to ensure the full value of any orthodontic

study desired. These casts are a highly valuable adjunct, for the delineation of contours, etc., of the periodontal tissues, and for recording hard-tissue anomalies or alterations.

(4) With radiographs and casts at hand, a meticulous examination of the hard tissues is made, employing the most rigid and standardized technique. Details are entered upon a specially prepared chart, which allows for pictorial recording wherever possible. The diagrams of the teeth include each elevation of each tooth, and are of unusually large size, allowing adequate space for the use of symbols, of which about sixty are employed. Separate gummed diagrams of the temporary teeth are prepared in such a way that they can be superimposed wherever required on the chart of the permanent teeth. These gummed diagrams are drawn to such a scale that, inserted singly or in multiple, they permit clear, readily recognized, recording of data in cases where any combination of temporary and permanent teeth may be present. (5) Very careful recording of the condition of the soft tissues is made, having again at hand the radiographs and the casts. Specially adapted peridentimeters are employed to measure accurately at six points on the periphery of each tooth the depth of the crevice. Colour estimations of various areas of the gingivae and oral mucosa are recorded, using a colour standard of twenty-four shades. These records are made on the same large diagram as that used in connection with the hard tissues. Vitality tests and transillumination observations are made.

(6) Data of significance from the orthodontic standpoint are recorded on a special orthodontic chart. (7) Bacteriological examinations are made at intervals, and qualitative and quantitative records entered on a special bacteriological and pathological chart. (8) Biochemical studies of the saliva, etc., made at intervals, are recorded on a special chart. (9) Radiographic and transillumination findings, apart from disclosed areas of dental caries, are entered on another chart, to facilitate future use of the records for special references.

All the charts in the above system are incorporated in a special folder, which likewise contains the radiographs. At the end of a 6-month period, another examination of the hard and soft tissues is made, including bite-wing radiographs, but not including impressions. At the end of the year-period, a third examination, identical with the

first, and following the same standardized technique, is made. All records, casts, etc., are filed in a special record-room, under the charge of archivists, and are available there for study to anyone interested.

110. INFLUENCE OF VARIATIONS IN MANIPULATION UPON VOLUME CHANGE AND STRENGTH OF AMALGAM

Marcus L. Ward, D.D.S., D.D.Sc., F.A.C.D., and Erman O. Scott, M.S., School of Dentistry, University of Michigan, Ann Arbor, Mich.

Since our report a year ago upon this subject (*Journal of Dental Research*, 1931, xi, p. 481; June), we have continually rechecked the previous year's work. Practically everything was easily rechecked excepting our data relating to packing pressure and its effect upon dimensional changes. Last year we reported that the packing pressures up to approximately 5250 lbs. per sq. in. lessened expansion with alloys which expanded, and increased shrinkage with those which shrank. We also reported that, up to that time, there appeared to be no marked effect from increasing packing-pressure between approximately 5250 lbs. and 21,000 lbs. per sq. in.; and beyond this amount, up to approximately 227,500 lbs. per sq. in., there was no initial shrinkage and an expansion of 8 microns per cm. during the first twenty-four hours. On account of the significance attached to the quantity of mercury combined with the silver in these alloys, by many workers who are interested in the purely chemical aspects of these products—and the fact that, with increased packing-pressure, there was a gradual diminution in the percentage of mercury retained and therefore also in the amount of Ag_3Hg_4 formed—we reconstructed our equipment so that we had better control of higher pressures, and devoted a great deal of work to a further study of the effect upon dimensional change of increasing packing-pressure. We have found, with the alloy to be designated No. 1 in our full report, that the effect of increasing packing-pressure upon shrinkage or lessening the expansion, depending upon the behavior of the alloy, extends farther than we indicated last year. Our experience leads us to believe that this effect may extend to 16,000 lbs. pressure per sq. in.; and that 32,000 lbs. per sq. in. probably more accurately locates the place

where expansion returns with increases in packing pressure than does the 21,000 lbs. per sq. in. reported last year. With these two changes in the location of these phenomena, our work as reported last year appears to stand without need for revision.

In connection with our study of varying packing-pressure this year, we began by jarring the amalgam into the mold and allowing it to set without any pressure except that of gravity and the jarring. We have continued these pressures through the ranges involved in practice and up to 256,000 lbs. per sq. in. Our work checks with that done by Dr. Taylor at the Bureau of Standards through the ranges involved in practice. As the pressures were extended, however, into the higher ranges, we found that, as was stated last year, there is a reversal of behavior of these alloys, while at the same time a constantly diminishing percentage of mercury is retained in the set mass. It has been known for a long time, we believe, that, with increased packing-pressure, a diminishing quantity of mercury is retained in the set mass of amalgam. It is significant, however, that there should be a sharp alteration in the shape of the dimensional-change curve, and a return of expansion which, in our work, has extended beyond six days. These changes seem to refute the theory that expansion is dependent alone upon the formation of Ag_3Hg_4. There is the possibility that these changes are physical, owing to the extremely high pressures to which the amalgams have been subjected. The fact that they extend over a long time and in such quantity, however, seems further to prove that some other chemical change than that involved in the formation of Ag_3Hg_4 has taken place. When the mass of amalgam has had no pressure and has been jarred into the mold, these expansions are extended over a much longer period of time than is provided for observation in Specification No. 356 of the Bureau of Standards. In this specification, one day is provided for observation. The results of our work show that this period of observation is too short. Our full report will present data indicating that the period of observation provided for in the Bureau of Standard's specification should be changed (1) when plenty of mercury has been left in the mass, and little or no pressure has been used in packing; (2) when high pressures have been used in packing; and (3) when certain types of alloys have been used that have not been fully annealed.

During the year, two other phases of variation in technique have been studied: one was concerned with the removal of mercury during the mulling process; the other, with deferring the time that packing was begun. With the five alloys chosen for this study—which seemed to cover the market quite thoroughly, as will be shown by the analyses in our full report—and suitable proportions of mercury and alloy mixed, there was from 2 to 4 microns more expansion when no mercury was removed during the mulling process. In a few cases, however, the mercury went into solution in the alloy so quickly that mulling became very difficult unless a little mercury was removed during the process. We are unable to say, therefore, whether it is advisable to remove the mercury; this should be determined by the manufacturer of each alloy, and the directions to cover this point stated on the package. In our work on the said five alloys, it was found that by deferring the time of packing, the mass stiffened slightly. As a result of the slight stiffening, less mercury was removed in packing; and in general there was slightly more expansion when the packing had been deferred up to as long as five minutes. In both cases, slightly more mercury was left in the mass, which will be shown in the analyses in our full report, and which supports those who have contended that expansion is due to the formation of the compound Ag_3Hg_4. (To be published in the *Journal of the American Dental Association.*)

111. AN ACCURATE TECHNIC FOR THE USE OF INTRA-ORAL RECORDS OF JAW RELATIONS AS ADVOCATED BY R. L. HANAU

W. H. Wright, D.D.S., B.S., F.A.C.D., School of Dentistry, University of Pittsburgh, Pittsburgh, Pa.

Hanau was the first to point out, define, and analyze the factor of "*realeff*" (*re*silient *a*nd *l*ike *eff*ect), as encountered in mucosa-supported prosthetic dentures. He showed that the geometrical reproduction of the condylar guidance was not required in the articulator, for movements of articulator members need not be identical, but must be equivalent to anatomical movements of the jaws. Hanau advocated that jaw-relation records for articulator mountings and adjustments should be unstrained (magnitude of force, zero), because unstrained records only can be controlled by the patient and dentist. To com-

pensate the functional requirements of "realeff" he proposed strained (pressure) and unstrained (no pressure) records with which to adjust the articulator prior to relief-grinding. The use of intra-oral jaw-relation records and suitable bases upon which they may be recorded, although a serious handicap at first, have since been adapted to the exacting requirements of the Hanau method. The writer's technic is as follows:

He recommends vulcanite denture-bases, which meet the requirements of retention and stability. A wax occlusion-rim, adapted to the upper denture-base and corrected for esthetics in the mouth, is transferred to the articulator by use of a face bow. The upper base and rim is reinserted, whereupon the patient is directed to close into a pyramid of softened, black, carding wax on the anterior region of the lower denture-base until the required intermaxillary space has been determined. Balanced centric jaw-relation is recorded by having the patient close, without biting pressure, upon pyramids of softened base-plate wax sealed to the posterior regions of the lower denture-base. The jaw must be in the retruded rest-position, previously determined by visual and tactile observations. The black-wax intermaxillary-space record on the lower base determines the proper opening component of centric jaw-relation. The lower denture-base is mounted on the articulator with this centric relation-record, after which it is checked by retesting in the mouth. A tracing device may be used to confirm centric relation. The articulator is adjusted by the use of unstrained protrusive relation-records, which are made in rods, 5 mm. in diameter, of softened pink-wax, while the mandible is protruded 6 mm. Articulator settings are rechecked by testing mouth records on the articulator, and articulator records in the mouth. A method for making a protrusive relation-guide to aid in obtaining mouth records is described. The use of, and method for obtaining, lateral-relation rest-records is described, although lateral relation-records are not recommended except where protrusive records are not available. The lateral indications on the articulator are set by use of Hanau's formula: $L = \frac{H}{8} + 12$. (Horizontal condyle-indication divided by 8, plus 12, equals the lateral-indication setting.) When trial dentures are examined in the mouth, a second series of protrusive

relation-records are made and used to confirm or change the original articulator settings. Upon completion, the dentures are again mounted on the articulator with a new centric-relation rest-record, the articulator is adjusted and tested by use of protrusive-relation rest-records after which the teeth are spot- and paste-ground, and finally corrected for lateral interference by use of the Hanau "correction technic." The teeth are finally ground to the "rocking fit," polished with rubber-emery wheels, cleansed, and inserted for an initial trial of not more than one day.

X. Data of Executive Proceedings

A. Lists of the officers, and new members, elected[37]

a. Officers (1932–33)

President—R. W. Bunting, University of Michigan. *President-elect*—E. H. Hatton, Northwestern University. *Honorary Vice-presidents*—Bernhard Gottlieb, University of Vienna; J. Frank Colyer, Royal College of Surgeons of England. *Vice-president*—J. L. T. Appleton, Jr., University of Pennsylvania. *Treasurer*—William Rice, Tufts College. *Secretary*—William J. Gies, Columbia University.

b. New members[38]

Mary Caldwell Agnew (Mrs.), M.A., Lecturer in Biochemistry, College of Medicine and Dentistry, West China Union University, Chengtu, Szechwan, China

Sumter S. Arnim, B.S., D.D.S., Dental Fellow, Medical School, Yale University

Henry A. Bartels, B.S., D.D.S., Instructor in Oral Pathology, School of Dentistry, Columbia University

Hermann Becks, M.D., D.D.S., Research Assistant-Professor of Pathology, Dental School, University of California

Basil G. Bibby, B.D.S., Rockefeller Fellow in Dentistry, School of Medicine and Dentistry, Rochester University

[37] Lists of the members and officers as of December 1, 1931, were published in the *Journal of Dental Research*, 1931, xi, p. 910.

[38] Since the adjournment of the Columbus meeting, new sections of the Association have been organized in Columbus, O., Louisville, Ky., and Prague, Czechoslovakia. The Association is now composed of five national divisions and twenty sections.

Paul E. Boyle, D.M.D., Instructor in Operative Dentistry, Dental School, Harvard University

Allan G. Brodie, D.D.S., Professor of Orthodontia, and Director of Graduate Course in Orthodontia, Dental School, University of Illinois

Homer C. Brown, D.D.S., F.A.C.D., Secretary of the Research Commission, American Dental Association, Columbus, Ohio

Alden J. Bush, D.D.S., President-elect, Ohio State Dental Society, Columbus, Ohio

C. Willard Camalier, D.D.S., F.A.C.D., Chairman of the Legislative Committee, National Association of Dental Examiners, Washington, D. C.

Karel Cěrný, M.D., Director of the State Dental Institute, and Docent at Charles University, Prague

Richard L. Coleman, B.Sc., Hartford, Conn.

H. V. Cottrell, D.D.S., Professor of Prosthesis, Dental School, Ohio State University

William H. Crawford, D.D.S., Associate Professor of Dentistry, Dental School, Columbia University

Kent K. Cross, D.D.S., B.A., Graduate Student in Anthropology, University of Denver

H. Trendley Dean, D.D.S., Head of the Dental Division, National Institute of Health, Washington, D. C.

Robert P. Dressel, D.D.S., Associate Professor of Crown and Bridge Work, Dental School, Western Reserve University

H. Shirley Dwyer, D.D.S., Supervising Dentist, Department of Health, New York City

John J. Enright, Ph.B., M.S., Ph.D., Dental Research Fellow, Mellon Institute, University of Pittsburgh

Willard C. Fleming, D.D.S., Assistant Professor of Operative Dentistry, Dental School, University of California

J. Raymond Gill, D.D.S., Associate Professor of Crown and Bridge Prosthesis, Dental School, University of California

Louis I. Grossman, D.D.S., D.M.D. (Rostock), Medical Arts Building, Philadelphia, Pa.

Bernice T. Horton (Mrs.), M.S., Instructor in Bacteriology, Ohio State University

Aaron Isaacs, B.Sc., Associate Chemist, Bureau of Standards, Washington, D.C.

Jan Jesenský, M.D., Director of the Dental Clinic, Charles University, Prague

Harry Kaplan, D.D.S., Dental Surgeon, Episcopal Eye, Ear and Throat Hospital, Washington, D. C.

Paul C. Kitchin, B.Sc., M.Sc., D.D.S., Assistant Professor of Clinical Dentistry and Histology, Dental School, Ohio State University

František Kostečka, M.D., First Assistant at the Dental Clinic, Charles University, Prague

Wilton M. Krogman, Ph.D., Associate Professor of Anthropology, Graduate School, Western Reserve University

William H. G. Logan, D.D.S., M.D., M.S., LL.D., F.A.C.D., F.A.C.S., Dean, Dental School, Loyola University (Chicago)

Anton E. Loos, M.D., First Assistant at the Dental Clinic, German University, Prague

Ewing C. McBeath, M.D., D.D.S., B.S., Associate Professor of Dentistry, in charge of Children's Dentistry, Dental School, Columbia University

Robert D. McFarland, D.D.S., Instructor in Operative Dentistry, Dental School, Ohio State University

Clinton T. Messner, D.D.S., F.A.C.D., Chief of Dental Service, U. S. Public Health Service, Washington, D. C.

Raymond E. Myers, D.D.S., Assistant Professor of Operative Dentistry, Dental School, University of Louisville

Friedrich Neumann, M.D., Formerly Assistant, State Dental Institute, Prague; Trida 28, Rijna 3, Mor Ostrava, Czechoslovakia

František Neuwirt, M.D., Chief of the Surgical Department, State Dental Institute, Prague

Norman C. Ochsenhirt, B.S., M.S., M.D., Assistant Professor of Oral Surgery, Dental School, University of Pittsburgh

John T. O'Rourke, B.S., D.D.S., F.A.C.D., Dean, Dental School, University of Louisville

Samuel J. Randall, D.D.S., Major, Dental Corps, United States Army; in charge of the Dental R. O. T. C., Dental School, Ohio State University

Arthur T. Rowe, D.D.S., Professor of Dentistry, Chief of Prosthesis, Dental School, Columbia University

Robert W. Rule, D.D.S., Professor of Operative Dentistry, Dental School, University of California

William B. Ryder, D.D.S., Instructor in Operative Dentistry, Dental School, University of California

Eugene W. Skinner, A.B., M.S., Ph.D., Assistant Professor of Metallurgy and Dental Technology, Dental School, Western Reserve University

Karel Wachsman, M.D., Chief of the Orthodontia Department, State Dental Institute, Prague

David Weisberger, B.S., D.M.D., Dental Fellow, Medical School, Yale University

Warren Willman, B.S., D.D.S., Instructor in Operative Dentistry, Dental School, Loyola University (Chicago)

E. Alfred Wolf, Ph.D., Associate Professor of Physiology, Department of Zoology, University of Pittsburgh

Robert C. Zeisz, D.D.S., Assistant Professor of Crown and Bridge Prosthesis, Dental School, University of California

Total number of new members, 49

Total membership (May 15, 1932), 283

B. NAMES OF MEMBERS PRESENT AT ONE OR MORE SESSIONS

(Arranged in sectional groups)

Ann Arbor.—Brown, Bunting, Jay, Lyons, Rickert, Vedder. *Boston.*—Boyle, Morse (F. W.), Rice. *Chicago.*—Black, Blayney, Boulger, Coolidge, Hatton, Kronfeld, Logan, Noyes, Nylander, Skillen, Willman. *Cleveland.*—Chase, Hill, Myers. *Columbus.*—Brown, Bush, Cottrell, Kitchin, McFarland, Randall. *Halifax.*—Thomson. *Louisville.*—Beust, Myers, O'Rourke. *Minneapolis.*—Brekhus. *New York*—Gies, Leonard, Rosebury, Waugh, Zemsky. *Philadelphia.*—Appleton, Cook, Prinz. *Pittsburgh.*—Dewey, Ochsenhirt, Swanson, Van Kirk. *St. Louis.*—Wheeler. *Toronto.*—Agnew (Mrs. R. G.), Agnew (R. G.), Husband, Webster. *Washington.*—Keilty, Messner, Paffenbarger, Souder, Taylor. *Not yet members of a section.*—Bibby (Rochester, N. Y.), Bryan (Iowa City). Total.—58

Quotations on the Status of Dentistry (continued)

training of better qualified dentists. Dentistry is a profession which has become firmly established in its own right, and one which comprises a number of specialties. *It would lose much by becoming a minor subdivision of medicine* [italic not in the original]. It had best retain its independence.—*W. McKim Marriott, M.D., Dean and Professor of Pediatrics, Medical School, Washington University, St. Louis, Mo.; Journal of Dental Research,* 1931, xi, p. 807; October.

Medicine and medical education have troubles of their own which will not be alleviated by attempting to swallow whole another profession; a profession, which, by and large, does not want to be engulfed. And a profession like dentistry, with a hundred-year history, deserves to have its feelings considered. You may call dentistry a specialty of medicine, but that does not make it so; and it is none the less valuable for that fact. I can see no reason why the degree, Doctor of Dental Surgery, honestly held and honorably upheld, should not in the future deserve equal respect and esteem from the public with the degree of Doctor of Medicine, provided it is held by a similar type of man. And whatever their future relationship may be, let medicine and dentistry now go forward side by side as friendly collaborators in the estimable undertaking of offering help to those who need it and adding to the happiness of life as much as to the length of its span.—*F. T. Van Beuren, Jr., A.B., M.D., Associate Dean, and Associate Professor of Surgery, Columbia University College of Physicians and Surgeons, New York City; Journal of Dental Research,* 1932, xii, p. 249; April.

We believe that the best interest of the dental profession, the public and all others concerned can best be served by a *continuation* of the separate organization of the dental profession. The fundamental soundness of this contention has been proved by the ninety-two years of continuous and remarkable progress of the dental profession, despite many handicaps, and important and serious opposition. We are convinced that the dismemberment of the dental profession through adoption of some of its parts by the medical profession, and the relegation of the remainder to comparatively uneducated technicians would seriously depreciate the quality of dental ministrations to the public. We believe that any advantages that might possibly arise from such destruction of the dental profession would be more than equalled by the development of dentistry into the full health service *equivalent* of an oral specialty of the practice of medicine, and this could be accomplished without the disadvantages that would accompany the former procedure.... The fact that the dental profession [like every other profession] falls short of perfection should not subject it to unreasonable attack, especially from those who should be most interested in fostering its progress.—*Report of Committee on Dental Education, New York Academy of Dentistry; adopted by the Board of Governors, April 14, 1931; History of the New York Academy of Dentistry, B. B. Palmer; 1932, p. 51; April.*

Important Books Received

Sun Yat-sen versus communism: new evidence establishing China's right to the support of democratic nations. By Maurice William, D.D.S., F.A.C.D., New York City. 1932; pp. xx + 232; 7 x 4¾ in.; no illustration; $5.00. Williams and Wilkins Co., Baltimore, Md.

The New York Academy of Dentistry: an historical sketch of the first decade (1921-1931). By Bissell B. Palmer, D.D.S., F.A.C.D., New York City. 1932; pp. 81; 6⅝ x 4 in.; 1 illustration. New York Academy of Dentistry, New York City.

The way of health insurance. By A. M. Simons, B.A., and Nathan Sinai, D.P.H., Research Staff of the Committee on the Study of Dental Practice of the American Dental Association. 1932; pp. 215; 6⅝ x 3⅞ in.; no illustration; $2.00. University of Chicago Press, Chicago, Ill.

Gold inlays by the indirect system. By Henry W. Gillett, D.M.D., F.A.C.D., Professor of Dentistry, Dental School, Columbia University; and Albert John Irving, D.D.S., New York City. 1932; pp. xiii + 584; 7⅛ x 4½ in.; 539 illustrations; $8.00. Dental Items of Interest Publishing Co., Inc., Brooklyn, N. Y.

Practical dental metallurgy. By Joseph Dupuy Hodgen, D.D.S., Professor of Operative Dentistry, College of Dentistry, University of California; revised by Guy S. Millberry, D.D.S., Professor of Chemistry and Metallurgy, and Dean, and John S. Shell, B.S., Assistant Professor of Chemistry and Metallurgy, College of Dentistry, University of California. *7th ed.* 1932; pp. 470; 6 x 3½ in.; 86 illustrations; $3.75. C. V. Mosby Co., St. Louis, Mo.

The art of porcelain in dentistry. By Fred R. Felcher, D.D.S., Chicago, Ill. 1932; pp. 360; 7½ x 4¼ in.; 277 illustrations; $9.00. C. V. Mosby Co., St. Louis, Mo.

A child's book of the teeth. By Harrison W. Ferguson, D.D.S. *Revised and enlarged.* 1932; pp. 106; 6⅛ x 4 in.; 126 colored illustrations; $0.68. World Book Company, Yonkers-on-Hudson, New York.

INTERNATIONAL ASSOCIATION FOR DENTAL RESEARCH

Meetings in 1931–32

SECTIONS. *Ann Arbor:* November 2. *Boston:* December 21, February 11, May 23. *Chicago:* October 9, January 17, March 11, May 20. *Cleveland:* December 14. *Columbus:* April 29. *Halifax:* October 2, November 27, January 29. *London:* January 20, March 9. *Louisville:* April 19. *Minnesota:* November 30, January 25, February 29, March 28, April 25. *New Haven:* December 7, February 17. *New York:* December 10, May 10. *Philadelphia:* November 24, March 4, April 15, June 3. *Pittsburgh:* October 5, November 2, December 7, January 4, February 1, March 7, April 4, April 25, June 23. *Prague:* May 3. *St. Louis:* October 13, January 12, April 12. *San Francisco:* March 9. *Toronto:* November 12, March 8, April 19. *Washington:* October 13, March 5.

ASSOCIATION. Tenth general meeting: Columbus, Ohio, March 19 and 20, 1932.

All persons interested in dental research are invited to attend the scientific meetings of the Sections and of the Association.

INFORMATION FOR PROSPECTIVE SUBSCRIBERS OR CONTRIBUTORS

THE JOURNAL OF DENTAL RESEARCH is dedicated to the advancement of research, and to the dissemination of knowledge, pertaining to the teeth and mouth and to their relations to the body as a whole. It publishes original investigations and reviews in these fields, and in the sciences allied with or applied to them. Issued bi-monthly, at the *ends* of the months of February, April, June, August, October and December, each volume contains at least 600 pages, for which the subscription price is $5.00.

This JOURNAL is the official publication medium of the dental organizations named on the title page of this cover. Although without a "policy," the JOURNAL represents an unwavering purpose to keep widely open the channel to freedom of *responsible* and *respectable* expression of truth and opinion, by individuals or organizations, without qualification by or for any views its editors individually may entertain. In accordance with this purpose, papers contributed by societies are controlled and edited by the respective associations through their official representatives.

THE JOURNAL OF DENTAL RESEARCH circulates widely among the most enlightened and progressive dentists and physicians, and among the leading libraries, thus assuring the degree and quality of publicity for its contents that the best dental literature merits. Therefore there can be no important occasion, except in very special instances, for the detailed presentation elsewhere of a paper published in this JOURNAL. Accordingly, to prevent waste of the JOURNAL'S resources in needless duplicate publication, and also to lighten the labors of students of the literature of dentistry, papers in this JOURNAL are not published in, or reprinted from, other dental journals, except for unusual professional reasons.

Authors of papers *on original research* will receive, free of charge, 50 reprints of their papers, *if they indicate their desires before the issue containing them goes to press.* Copies in any number may be obtained at prices that will be quoted on request.

Address all communications relating to editorial matters to the JOURNAL OF DENTAL RESEARCH, 632 West 168th Street, New York City; business communications, to the JOURNAL OF DENTAL RESEARCH, Mount Royal and Guilford Avenues, Baltimore, Md.

CONTENTS

June, 1932

International Association for Dental Research. Scientific proceedings of the Tenth General Meeting, Columbus, Ohio, March 19–20, 1932. Compiled by *William J. Gies*, F.A.C.D., *General Secretary* 411

President's address: The value of research in dentistry. *A. E. Webster*, D.D.S., M.D., L.D.S., F.A.C.D. 412

Index of names of participants, and sequence numerals of corresponding abstracts 414

Abstracts of papers *presented orally* (1–53) 415

Abstracts of papers *read by title* (54–111) 483

Vienna members (54–73) 483

Other members and guests (74–111) 512

Data of executive proceedings 565

List of officers elected 565

List of members elected 565

WAVERLY PRESS, INC.

BALTIMORE, U. S. A.